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SCIENCE AND THE PRESS

THE growth of interest in the presentation of science in the Press during the past four or five years is noteworthy. The Royal Society Scientific Information Conference in 1948 stimulated a keener interest in the presentation of science to scientists; thus, for example, there was a discussion on the presentation of technical information at the Birmingham meeting of the British Association in September 1950, various scientific and learned societies have issued fuller guidance for the writers of papers presented to them for publication, and the Presentation of Technical Information Discussion Group has been formed as a sequel to Prof. R. O. Kapp's lectures on the subject at University College, London. Interest in this aspect has been recently quickened by the stress laid on the importance of effective communication in order that the utilization of the results of research by industry may be expedited.

Here, however, we are concerned also with the second aspect of the subject—the presentation of science to the public. Discussion of this aspect has tended to centre in Great Britain around the function of the British Association and the manner in which the annual meeting of that Association could best facilitate the exposition or interpretation of science to the non-specialist—if not indeed to the general public. It is increasingly manifest that the use made of scientific advances, and ultimately the continuance of adequate support for scientific research, depend upon the existence of a climate of opinion which understands sufficiently the nature of scientific work and the conditions under which it is most fruitfully carried out. It is also becoming recognized that there are widespread fears about science and the effect of its activities, springing essentially from ignorance, and that the persistence of that ignorance may affect the future of science itself.

Several papers in the *New Zealand Science Review*, published by the New Zealand Association of Scientific Workers, discussed three years ago these questions, particularly the improvement of presentation of scientific papers and the relations between science and the Press; and a long article by Prof. I. B. Cohen in *Impact of Science on Society* in the summer of 1952 discussed the education of the public in science, considering, however, the general educational aspect, rather than the appropriateness or effectiveness of the particular vehicles—the written word, radio or television—by which that education is to be achieved. Early this year in his Clayton Memorial Lecture, "The Public Influence of Broadcasting and the Press", Sir William Haley, commenting on the more enduring effect of the printed word compared with the spoken word, indicated the supreme importance of the Press if it set out to use its opportunities for influencing and improving public understanding.

Those opportunities and the whole technique of presentation in the Press have been discussed more fully in two recent papers, both entitled "Science and the Press". The first of these, which was delivered by Mr. L. J. F. Brimble before the Royal

Society of Edinburgh on January 11, received wide publicity at the time and has now been published. The second, by Mr. W. E. Dick, editor of *Discovery*, appears in *Impact* of September (Unesco, 19 Avenue Kléber, Paris, 16), and discusses further some of the points raised by Mr. Brimble as well as reviewing the part which the printed word has played in the development of science itself.

It is one of the merits of Mr. Dick's article that he puts the relations of science and the Press in their historic perspective. He does not over-stress the importance of the printed word as a means of communicating scientific knowledge, as is sometimes done by protagonists of mechanical devices for recording, classifying, filing and disseminating scientific and technical information. Even to-day, personal contact and discussion have a value not merely in stimulating thought and the flow of ideas but equally in the exchange of the residual information which is liable to be missed by abstracting and indexing systems.

This factor deserves more weight than it often receives in considering how far it is worth while extending the field of an abstracting system, and it is worth stressing here because the relations between science and the Press are best discussed on such a practical basis and not in terms of theory. They will, in fact, vary according to the conditions of the period under consideration and the influence of other means of communicating knowledge. Both, however, are, as Mr. Dick reminds us, intimately concerned with the freedom of the Press, and if the struggle for a free Press was waged by men of letters rather than by the scientists, it is on the latter that the onus lies for defending that freedom against encroachment to-day.

Mr. Dick points out that the establishment of writing as a professional activity of the first importance dates from the French Encyclopædia of the early eighteenth century. From that time the Press has been indeed a Fourth Estate, able to contribute its full share to the advancement of knowledge, whether in science or in other fields. Scientific periodicals soon became the main method of communicating the results of research and the indispensable tools of the scientific worker, though societies like the Royal Society for the Encouragement of Arts, Manufactures and Commerce, the Lunar Society, the Manchester Literary and Philosophical Society and the Royal Institution also forged links between industry and science in Britain. By the beginning of the nineteenth century, daily newspapers were well established and there were also some vigorous periodicals. Journalists with a good sense of what interested the public began to record events in the world of science, and this tendency was encouraged by the formation of various associations aimed at strengthening the ties between the world of science and the general public, such as the Deutsche Naturforscher-Versammlung and the British Association for the Advancement of Science.

These associations recognized that the help of the Press was indispensable for the purpose just indicated; but they also aimed at providing a common meeting ground for all scientific specialists. This function has steadily increased in importance with the growing fragmentation of science, and in recent years particularly, the mounting costs of publication have set limits to the economic production of highly specialized periodicals with only a restricted circulation; indeed, the cost of publication of its journal may to-day absorb as much as thirty per cent of the annual income of a scientific or technological society.

This position, and the difficulty of securing effective coverage of such literature by abstracting bureaux, have led to suggestions that the scientific paper is no longer the most appropriate means of recording and disseminating scientific knowledge. Mr. Dick comments, however, that any attempt to rationalize scientific publication would involve one great danger that the multiplicity of periodicals has practically eliminated. When there were only a few scientific periodicals, some first-class scientists, such as Joule and F. W. Lanchester, found great difficulty in getting novel work published. There is always a distinct risk that the most conscientious editor or editorial board will fail to recognize the true value of a paper in the Joule or Mendel class. It is rightly maintained that the advantage to the truly original scientific thinkers of a rich variety of periodicals to which they can submit their work offsets the embarrassment to searchers of the literature caused by such variety.

If, however, we are to indulge in such variety, it is essential that, as both Mr. Brimble and Mr. Dick insist, we should give more attention to the preparation and presentation of scientific and technical papers themselves. Even a genius may fairly be expected to take some care that prolixity and careless writing do not increase what may well be the inherent difficulty of following an original and unfamiliar idea. "Slovenly writing", wrote Bishop H. H. Henson, "is nothing but bad manners in composition", and though that precept might be heeded above all by the scientist who attempts to expound his results to the general public, it equally applies in the presentation of his work to his fellows, whether specialist in his own field or not. Mr. Brimble strongly deprecates the tendency to rush into print and, without discussing the controversial question of the most appropriate means and place for the publication of detailed research results, it may be asserted that the length of most scientific and technical papers would probably be reduced and their clarity and value enhanced if, as he suggests, before submitting a communication, every scientist satisfied himself that he had said what he wanted to say, and in the minimum number of words, and that it was worth saying at all.

Quite apart from the saving of space, the improvement in quality resulting from such general practice could be most important. "Wherever," wrote George Stuart Gordon, in "Anglo-American Literary Relations", "a man has fairly set down the best that he knows about the thing he knows best, and in words

that tell his meaning, there, always, will be literature." To the extent to which the specialist achieves that ideal, he will solve, by and large, the problem of communication, whether to his fellow scientists or to his fellow citizens in general.

The operative clause is "in words that tell his meaning", and its significance is well illustrated by Mr. Dick's reference to Charles Darwin's "On the Origin of Species". It was written as a scientific treatise for Darwin's fellow scientists, but reached a far bigger public than either author or publisher foresaw. Darwin made no concession to popular appeal beyond lucidity of thought and of expression, and his success with this one book may be fairly attributed to his plain, unpretentious but most lucid style. There is thus a tradition of good writing among British scientists which may well make us hesitate to accept the pronouncement that the study of modern science destroys the ability to write good English. Weakness in this respect may well arise, not so much from the study of science, as from defects in education: it is not the scientist alone who mars his exposition by jargon. The tendency is widespread and deeply embedded, despite onslaughts ranging from those of Sir Arthur Quiller-Couch to Sir Winston Churchill. None the less, the use of jargon has dangers, as both Mr. Dick and Mr. Brimble emphasize, and the success of the "Origin of Species" as a best-seller far beyond the confines of the scientific world is a striking demonstration of the fallacy that a scientist is bound to rely on jargon. The book contained a new theory of evolution, the main points of which were not easy to grasp, and it was packed with unfamiliar details. Everyone, however, with any pretensions to being cultured read it, and many thoroughly grasped the main points of Darwin's theory.

In the face of this and other instances, it cannot be maintained even to-day that the important concepts of science are beyond ordinary comprehension. The task of communication, however, demands a greater effort at clarification than the scientist frequently troubles to make; but unless he makes that effort his work cannot be expounded or interpreted even to his fellow scientists. Still less can the task of explanation to the general public be carried out by himself or anyone else. As Dr. Barbara Wootton recently remarked, in her presidential address to the annual conference of Aslib, efficient communication, in the social sciences or in any other field, is only possible on the basis of common experience, and it is not only in the social sciences that the use of jargon introduces pitfalls. Jargon is peculiarly liable to cause the confusion to which Dr. Wootton refers. Such words tend to bear one meaning to the scientist and another meaning—possibly several different meanings—to other scientists or to non-scientists, and serious misunderstandings arise even in the physical sciences, where there is less risk than in the social sciences of discussions about words being confused with discussions about the things which the words are supposed to represent.

From the point of view of communication, however, the use of jargon should be eschewed because of the way in which it contributes to the emotional entanglements which Dr. Wootton rightly characterizes as the most serious consequence. That is also the main reason why, though the interpretation and exposition of science to the general public must be carried out by co-operation and understanding between scientists and the Press, the major responsibility for it must lie on the scientist. However much they may value and seek the co-operation of the Press, scientists to-day have a public duty to see that their work is clearly explained at the appropriate stage to the public.

As Mr. Dick remarks, the public is entitled to a reasonable amount of information about all researches supported from public funds, and it is now better appreciated that the presentation of such information has a close bearing on its utilization for some practical purpose in industry. Even for independent or privately financed research, a reasonable degree of publicity is desirable from the point of view of science itself, as Prof. Kirtley Mather has indicated. Publication for the non-scientist is an issue of public importance and can vitally affect the advance of science itself. It can no longer be regarded as a matter of privilege to be granted as, when and if the scientist so decides. What is the appropriate stage may be a matter of judgment, and of discussion; but it should no longer be an arbitrary decision.

Both Mr. Brimble and Mr. Dick in these two papers have much to say that is helpful to the scientist and to the Press in regard to this task of popular exposition and interpretation. Mr. Brimble stresses, for example, the importance of the scientist being readier to co-operate and more accessible to the Press; and part at least of the value of both papers lies in the extent to which they should remove some causes of misunderstanding and friction. Mr. Brimble, for example, paid a generous tribute to the improvement, almost out of all recognition, of British newspapers, by and large, in their presentation of scientific news and their interpretation of scientific discovery, and to the intellectual leadership in the ordinary newspaper; the Press is still the most effective moulder of public opinion, and sound opinions must be based on knowledge of the facts. This tribute gives the greater force to his criticism of some general failings, which sometimes hinder men of science from co-operating as freely as they might otherwise do. Chief of these failings is the lack of appreciation that the very essence of science is accuracy, and that the checking and counter-checking necessitated thereby make it very rare for science to give what can be described as 'hot' news. The same point is made by Mr. Dick, who remarks that there is room for compromise here. Both papers should at least help scientists to realize the relatively low proportion of erroneous reports which appear in a daily newspaper, in spite of the pace at which the collection and publication of news proceeds. A sense of proportion, above all in regard to details, should go far to facilitate harmonious working.

While that suggestion applies particularly to the scientist, the question of factual accuracy is one

which concerns scientist and journalist equally. If the Press takes to heart Mr. Brimble's second major criticism, and is readier to admit and correct an error when under no legal pressure, much would be done to establish the conditions of confidence and mutual respect essential for effective co-operation. A reputation for accuracy depends at least in part on the readiness to acknowledge and correct inadvertent slips or errors. Such a reputation is a priceless asset which once lost is hard indeed to regain. There is an aside on the Press in Dr. R. M. Hutchins's brilliant little book, "The University of Utopia", on which a journalist might well reflect in this connexion. The Utopians, writes Dr. Hutchins, are a people trained to criticism, and since the blandishment of propagandists and advertising men would leave them unmoved, there is no point in indulging in it and there were no propagandists or advertising men in that happy country.

A third criticism made by Mr. Brimble also bears very closely on the vital question of the public relations of science and the maintenance of full freedom of investigation and communication with which both press-men and scientist are so closely concerned. He deprecates the tendency to expect leading men of science to commit themselves, immediately a new scientific discovery of paramount importance is made, to opinions concerning its human implications. Prematurely to do so is liable to impair rather than to improve and restore the public confidence upon which the continuance of public support of science ultimately depends.

Such reasons as these therefore demand much greater attention to this task of exposition and interpretation by scientists in general, and it is to be hoped that the misappropriation of the word 'communication' into a narrow technical field which Dr. Wootton deservedly castigated will not impede progress in this wide task of improving the communication of scientific knowledge to the world in general. Such misappropriation is perhaps particularly liable to hinder that more generous attitude to the scientific expositor which has been urged in these columns for many years. As Mr. Brimble remarked, it is very important that the expositors and interpreters of science as represented by science writers should be sure of the appreciation and support of their professional colleagues to which they are entitled.

When all that is possible has been done to improve the relations and co-operation between scientist and the Press, a large share of the responsibility for the interpretation and exposition of scientific discovery to the general public must rest upon such professional science writers. Some may be scientists, specially gifted as expositors or interpreters; some may be journalists by training, with special interest in or understanding of science or some branch of science; but from whatever side they have approached it, their position is essentially the same, and their success depends on a clear understanding of the public they are attempting to reach, the limitations of that public, and of the subject they are to expound. Only on that basis can their ability to assess values, and to interpret facts in language understood by all, make any real contribution to the public understanding of science. That task demands in its exercise the same qualities of mind and unswerving loyalty to truth as are demanded in laboratory or field investigations; nor can we expect men and women of the calibre which exposition and interpretation, as distinct from propaganda, demand to come forward in the numbers needed, unless their fellow scientists accord them the honour and respect they deserve and co-operate whole-heartedly with them in that task.

FREEZING AND DRYING BIOLOGICAL MATERIAL

Biological Applications of Freezing and Drying
Edited by R. J. C. Harris. Pp. xii+415. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 10 dollars.

FREEZING and freeze-drying are two techniques the practical development of which would have been impossible without advances in refrigeration technology. While extreme low temperatures can only be attained by liquefied gases, the relatively easy maintenance of 'deep-freeze' temperatures has made possible the preservation of delicate material such as spermatozoa and blood corpuscles. But low temperatures introduce new problems, particularly those of thermal and osmotic shock: because slow cooling reduces osmotic shock at low temperatures, especially in the presence of glycerol, most living cells survive slow cooling better than rapid or ultra-rapid freezing. Where survival of cells is unimportant, as in tissue sections or preparations for electron microscopy, rapid freezing has many advantages, and fixation at temperatures below −100° C. produces fewer ice-crystal artefacts in sections. A new method is described in this book for freeze-drying preparations for the electron microscope; in some cases the morphology of the freeze-dried and air-dried material differs, but in others, such as tobacco mosaic virus, the appearances are similar.

Dehydration after freezing is compatible with survival only for small organisms such as bacteria and yeasts, and there is no evidence of survival of mammalian cells with a water-content reduced to 10 per cent. Conflicting results have followed the experimental use of freeze-dried cornea; success has only been achieved in the rat, where the small size of the cornea may enable a non-viable graft to act as a skeleton for the ingrowth of host cells from the periphery. In rabbits such ingrowths would take longer, and may be too late to overcome the opacity developed in the centre of the graft. Freeze-dried blood vessels have been successfully grafted in dogs; but these, like grafts of freeze-dried nerve which do not elicit the homograft reaction, may be successful merely because they provide a scaffold for cells from the living tissue.

Plasma has been successfully freeze-dried for so long that the use of the dried product is accepted not only as equivalent but even as superior to stored liquid plasma. Repeated freezing and thawing of plasma results in instability of plasma proteins, but

a single thawing may occur without loss of essential properties before freeze-drying. The useful life of dried plasma varies with the degree of secondary drying, that is, with the residual moisture content and with the type of packing. The British transfusion bottle has an aluminium cap and a rubber washer; since rubber is permeable to water vapour the vacuum is best replaced by a dry inert gas. In the United States the evacuated container is placed in a tin which is also evacuated.

The volume under notice contains articles by fifteen authors, and deals with theoretical and practical aspects of freezing and freeze-drying of antibiotics, bacteria, viruses, blood products, milk and foodstuffs, and the preservation of living tissues. It also deals with the simple apparatus needed to apply freeze-drying techniques to dead tissue for histological work. There are inevitable inequalities in the different articles, but the book should be read by all who use freezing or freeze-drying. Apart from the line-drawings and micrographs, the illustrations are of extremely poor quality. S. T. COWAN

BEGINNINGS OF A WELFARE STATE

Studies in the Social Services

By Sheila Ferguson and Hilde Fitzgerald. (History of the Second World War: United Kingdom Series.) Pp. ix+367. (London: H.M. Stationery Office, and Longmans, Green and Co., Ltd., 1954.) 22*s*. 6*d*. net.

PROF. R. M. TITMUSS ends his penetrating social history of the Second World War, "Problems of Social Policy", by saying, "The disturbances to family life, the separation of mothers and fathers from their children, of husbands from their wives, of pupils from their schools, of people from their recreation, of society from the paths of peace . . . have left wounds which will take time to heal and infinite patience to understand". This present book, which although not written by Prof. Titmuss conforms closely to plans made by him, is, like its predecessor, a valuable contribution to our knowledge of family strengths and weaknesses, as revealed in a period of serious and prolonged strain; knowledge which is vital to the wise ordering of social policy. Except for the study of the nursing service, which, interesting as it is, does not really fit into the pattern of the book as a whole, the book is centred on the family. It starts with the family as it was in 1939, already reduced in size by the decline in the birth-rate during the previous half-century, and therefore with fewer members to call on for support and help in times of crisis, and discusses the strains to which it was subject—strains such as the dispersal of individuals, and, in bombed cities, whole neighbourhoods, the mobilization of husbands and fathers, the "unparalleled mobilization of women, and in particular, married women"—and how they were met.

Dislocation of family and neighbourhood life meant that there were many things which the family could no longer do for itself, and what the family and neighbourhood could no longer do for themselves the State must help them to do. The growing recognition by the Government and its various departments that it must help the family bear its responsibilities if women's efforts to "keep their homes together in the face of every adversity" were to be successful comes out in all the studies of which the book is made up. It is shown, for example, in the development of the emergency maternity service from a safety to a welfare measure, and in the new and extended functions which the Government assumed in connexion with the welfare of young children, both of which developments are here discussed at some length. Moreover, this participation by the State in family responsibility was, with some hesitation and certain exceptions, offered to all families who cared to take advantage of it; and these studies confirm the view expressed in "Problems of Social Policy", that one of the most far-reaching changes in social policy and administration which took place during the war years was the increasing readiness of the State to assume responsibility for warding off distress not only from the poor but also from all classes of society. Hence social service benefits came to be regarded by all concerned as among the rights of citizenship, a conception which is fundamental to the Welfare State as we know it to-day.

In general, one gains the impression from these studies that "the social stability of families as a whole, and of the nation as a whole was, under the circumstances, remarkable". Breakdowns inevitably occurred, however, and, as originally planned, this book would have contained studies of at least three symptoms of family breakdown—the war-time increases in juvenile delinquency, divorce and illegitimacy. Unfortunately, limitations imposed by the publication time-table only permitted the inclusion of one study, that of illegitimacy. This provides the material for two of the most interesting chapters of the book, chapters which demonstrate that the more careful examination of relevant statistics may lead to conclusions about the nature and extent of a social problem very different from those generally accepted. Thus, while the remarkably rapid rise in the number of illegitimate maternities from 26,569 in 1939 to 64,743 in 1945 has led to generalizations about the lowering of moral standards, especially among young people, the authors show that this contention cannot be supported if we relate these statistics to those relating to pre-marital conceptions. The war-time rise in illegitimate maternities was accompanied by an almost equally dramatic fall in the percentage of irregularly conceived maternities afterwards regularized by marriage; and, in fact, it was not until 1945 that the percentage of maternities conceived out of wedlock to all maternities rose above the pre-war figure. Moreover, when analysed according to the age of the mother, it was found that it was among the women over twenty-five rather than among their younger sisters that the rise had taken place. No attempt is made by the authors to arrive at a confident explanation of the situation thus revealed; this, they state, must await "a much more searching analysis of all the social, economic and psychological factors concerned in contemporary attitudes to sex relationship and marriage".

Despite its inconclusiveness, this sentence exemplifies a breadth of outlook which is characteristic of the book as a whole. Nowhere are war-time problems and policies studied in isolation; instead, we are continually brought back to the consideration of fundamentals of social need and national policy. Hence, although the studies contained in the book are specific and limited, they are likely to be of long-term value to both student and administrator.

M. P. HALL

YEAST TECHNOLOGY

Yeast Technology

By John White. Pp. xvi+432+17 plates. (London: Chapman and Hall, Ltd., 1954.) 55*s*. net.

THIS volume makes a welcome addition to the already large literature of commercial yeast technology. The author states in his preface that it is largely the outcome of a series of papers communicated by him to various journals, and in its general make-up it certainly bears unmistakable traces of its origin. There is a good deal of needless repetition which could have been obviated by more careful editing.

The greater part of this book is concerned with the manufacture of bakers' yeast on a commercial scale, as well as the important questions of quality of the product and biological control. From a reading of these chapters it is obvious that the author is a master of his subject. They could not well be bettered, and should be studied by every beginner entering the field of commercial yeast production. Unfortunately, when the author strays from his chosen field his touch is by no means so sure. The chapters on yeast genetics and food and fodder yeasts, for example, should either be entirely omitted or very greatly expanded. The chapter on yeast genetics as it stands at present is too scrappy and inadequate to be of any real service to a beginner. The treatment of brewers' yeast is also not very adequate. The chapter on this subject has been contributed by Dr. C. Rainbow, and it is clear that he has been hampered by lack of space; but he has certainly used the space he has been allowed to good purpose. In another edition this chapter should also be very greatly expanded. It would, for example, have been of great help to the practical brewer to be given more details of how to select his pitching yeasts and how to maintain his stock cultures in an active state.

The main purpose of this volume is to describe the commercial manufacture of bakers' yeast; and this is done with a wealth of detail in the early chapters and should be of the greatest value to beginner and experienced worker. The remaining chapters, apart from those on yeast genetics, food and fodder yeasts and brewers' yeasts, are concerned with such important subjects as yeast nutrients, structure and consistency of yeasts, aspects of yeast physiology and disposal of effluents from yeast factories. There are also chapters on the effect of aeration and temperature on yeast growth, and these will repay careful study.

The chapter on the microbiological control of yeast growth processes is particularly well done; but in another edition the author should give full details of how stock cultures of bakers' yeast are maintained and how fresh cultures are selected.

The information on the behaviour of bakers' yeast during panary fermentation is up to date and should be studied by every baker, even if he has only a rudimentary knowledge of chemistry. It may prevent him from laying the blame at the yeast manufacturer's door for his own mistakes.

The publishers are to be congratulated on the general make-up of this book; the quality and clearness of the various illustrations and diagrams are excellent and leave nothing to be desired. Apart from the criticisms which have been made—and they are all of a minor character—this book can be strongly recommended and should be acquired by everyone interested in this subject.

E. Barton-Wright

COSMIC EVOLUTION

Stars in the Making

By Cecilia Payne-Gaposchkin. Pp. xii+160+67 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1953.) 25*s*. net.

THE early writings of Dr. Payne-Gaposchkin (then Miss Cecilia Payne) provided much of the empirical knowledge that was used to test the theoretical predictions made by the late E. A. Milne and his contemporaries in their classical researches on stellar atmospheres. She has since become a leading worker on variable stars. In the present book she ranges over a wider field and addresses herself to a wider class of readers than in her previous writings. In doing so she reveals a talent for brilliant and stimulating exposition.

Dr. Payne-Gaposchkin calls her theme the drama of cosmic evolution. In her first two chapters on "The Actors" she gives a vivid description of the physical variety of the stars and of the physical conditions of interstellar material. The next three chapters describe "The Scene" that is witnessed by astronomical observation. In the reviewer's opinion, this is the best part of the book and includes much information that has not before been presented in a popular account. It deals with the physical characteristics of double stars, clusters of stars and the strikingly different stellar sequences found in galactic and in globular clusters, with galaxies and, particularly informatively, with the comparative study of the Milky Way galaxy and the Andromeda nebula, and with Baade's two stellar populations and the varying manner of their occurrence in different galaxies. Most of the collection of sixty-odd splendid plates at the end of the book illustrate this section. Several important observational advances in the past two years would have permitted some statements to have been made in a more categorical form had they been available when the book was being written.

The "Drama" itself has to be inferred from the analysis of this scene. Dr. Payne-Gaposchkin marshals the inferences that can be made about the ages of various astronomical systems and then seeks to show that other general indications are compatible with these in suggesting a certain evolutionary sequence. Many of her ideas are in keeping with some current trends in astronomical thought (though she does retain the now generally rejected fission theory of the origin of double stars). However, one would wish to see the ideas brought into closer relationship with theories of stellar structure at one extreme, and with some theory of the formation of galaxies at the other, before venturing an opinion upon them.

Dr. Payne-Gaposchkin likens her undertaking to trying to reconstruct the story of a film from the array of still pictures displayed outside a cinema. Her own reconstruction will provoke lively curiosity—even if the display does not yet carry the announcement, "coming shortly".

W. H. McCrea

OBSERVATIONS ON THE COLLAGEN SYSTEM*

By Prof. J. T. RANDALL, F.R.S.

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ALTHOUGH it is impossible for one group of workers to examine more than a few fundamental features of so complex a biological system, I wish to emphasize the need for an integrated outlook if we are to reach a proper understanding of the nature, structure and function of connective tissues. The physicist, in thinking of connective tissues, almost automatically concentrates his attention on the structural properties of the fibrous collagen; the biochemist likewise tries to characterize the protein by a precise analysis or to determine, perhaps, what sugars are present in the ground substance. The histologists and pathologists are aware more than any of us that these are but facets of the whole problem. Collagen fibres are a characteristic feature of all connective tissues and their derivatives, cartilage, bone, and lymph nodes. But all connective tissues are composed of four main constituents: cells, fibres, matrix or ground substance, and intercellular fluid. It is too often forgotten that the cell is the focus and origin of all tissues. If we are to reach a better understanding of the collagen system, more attention must be paid to the fibrogenic cells, to which the fibres and ground substance in all probability owe their origin. Here I shall consider three main types of problem: first, some biological and biochemical studies of fibrogenesis; secondly, physical investigations of collagen structure by means of X-ray diffraction and the electron microscope; and thirdly, the mechanism of precipitation of fibrous collagen from *in vitro* solutions.

Fibrogenesis

While it is recognized that development of fibrous material occurs outside the cell, the origins and early fibrogenesis of collagen fibrils have remained uncertain since the time of Schwann. Does the fibrous component of the connective tissues originate within the cytoplasm of the fibroblasts, on the cellular surface, or in the regions which lie between the cells? If the fibrils originate in the intercellular medium, it has to be decided whether they are formed or developed with the aid of a specific cellular secretion; such a secretion may itself be precipitated in the form of fibrils, which later develop into much larger entities and bundles. Alternatively, the postulated secretion may interact with the intercellular medium to form a fibrous complex.

By the use of the embryos of the fowl and of the rat, and particularly in tissue culture, the living fibrogenic cells have been examined by phase and ciné-microscopy. Fixed cells have been studied intact and as thin sections in the electron microscope, and cytochemical tests and biochemical assays have been carried out. Two types of structure have been observed: cytoplasmic filaments 100–500 A. in diameter, and cytoplasmic granules 0·5–3 μ in size. It is not known at present whether the filaments have any direct connexion with the cytoplasmic tubules and lamellæ observed by other workers in different types of cell. The filaments have been found in the four main types of cell associated with the rapid formation of collagen: in osteoblasts of the metatarsus periosteum and of membrane and endochondrial bone; in young osteocytes; in fibroblasts of tendon sheaths and the perichondrium; and in chondroblasts of hypertrophic cartilage. In the fibrous sheath of developing bone, the young osteocytes contain these structures, and no clear division can be seen between the cell boundary and the matrix. These observations are suggestive: but it is not yet known whether the filaments are collagenous; they may consist of some core material on which collagen is laid down. Although the filaments are a characteristic feature of the fine-structure of fibrogenic cells, they may not be concerned directly in the production of collagen.

Miss S. Fitton Jackson, who has made the observations I have described, has also directed attention to cytoplasmic granules in these cells. These had been observed previously by Fell and others but largely ignored owing to the ease with which they may be lost in the fixation process. The granules may be seen most readily in the living cell. Detailed studies show that the granules are complex in structure, and staining shows the presence of polysaccharide after removal of lipids and glycogen; the granules also stain characteristically for protein but do not respond to the Janus green stain for mitochondria.

From these and other observations it is reasonable to conclude that the granules are largely composed of an acidic polysaccharide–protein complex and show indications of phosphatase activity; possibilities of the presence of other components and enzymic activities cannot at this stage be excluded. Bottle cultures of almost pure strains of osteoblasts are providing material for detailed biochemical investigation by R. H. Smith. The granules may have a secretory function and be concerned either in the elaboration of the ground substance or of simpler molecular systems. There is at present no connexion between the cytoplasmic granules and filaments, but this possibility cannot be ignored.

Structure of Collagen

It is well known that collagen fibres possess a degree of structural organization found in few, if any, other proteins. About twelve years ago, electron microscope studies revealed an axial macroperiod of ~ 640 A., which has since been confirmed in collagens of widely different biological origin. This macroperiod has been found to be subdivided into a number of striations generally alternating in density. The macroperiod has been confirmed by low-angle X-ray diffraction, an aspect studied in great detail by Bear. High-angle X-ray studies reveal an imperfect fibre diagram which has been known for about thirty years. This diagram relates to the configuration and structure of the individual polypeptide chains or protofibrils, and differs in important ways from the characteristic diagram of the keratin–myosin–epidermin–fibrinogen group. Many models for the

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protofibril structure have been proposed, especially in recent years, but no satisfactory solution has yet been reached. As I shall show, new data are being obtained almost continually, suggesting new lines along which the investigations may proceed towards the complete derivation of the structure.

Although little is known about the structural arrangement within the 640 A. period, sub-bands of smaller size are frequently observed in electron micrographs. P. M. Cowan, A. C. T. North and I have recently obtained some evidence from coherent and diffuse X-ray scattering at small angles for the existence of a sub-unit of dimensions 220 A. along the fibre axis and 40–90 A. at right-angles. Attempts are also being made by R. E. Burge to relate the electron microscope results to the X-ray results by a determination of the density function for unstained and unshadowed pictures. In undried native fibres the unit also appears to be greater than that of the individual protofibril, as shown by the equatorial reflexions of quite large spacing obtained recently by North. These reflexions are not observed if the fibre is dried thoroughly and then re-wetted.

North has also obtained much improved high-angle diagrams by the technique of stretching; these results cannot be discussed in detail here. They are, however, remarkable for two things. First, the improved diagrams point much more strongly than any previously obtained to a helical configuration of the protofibrillar unit; it is the details of the helical configuration which are still baffling. Secondly, a comparison of the fibre extensibility with that derived from the low- and high-angle diagrams supports the suggestion of Bear that two types of region exist in the fibre and that these regions differ in their degree of order.

The absence of meridional reflexions between the equator and the 2·95 A. arc on the X-ray diagrams of stretched specimens, and the relationship $1/2{\cdot}95 - 1/4{\cdot}27 = 1/10{\cdot}14$ between the spacings of the strong layer lines, would be expected from a helical configuration with a unit repeating at heights of 2·95 A. and a pitch of either 10·14 A. or 4·27 A. The repeating unit may consist of one or more residues. The 10 A. pitch could be produced by (i) a single chain having a lead of 10 A. and about $3\frac{1}{3}$ units per turn; (ii) two intertwined helices each having a lead of 20 A. and about $6\frac{2}{3}$ units per turn; (iii) three intertwined chains each with a lead of 30 A. and 10 units per turn. (i) and (iii) each has an approximate pseudo-period of 30 A. and (ii) one of 60 A. A 4 A. pitch might similarly be produced by one, two or three interwoven helices with leads of 4 A., 8 A. and 12 A., respectively. The observed spacings have been indexed according to layer lines of a 30 A. period, but the fit is not exact. In practice, a helical structure may have a very long pseudo-period to which these systems of small layer-line indices would be approximations.

Mechanism of Collagen Precipitation

The precipitation of collagen from acid solution has been known for many years, and recent interest in the subject arises from the discovery that such precipitates may contain fibrils with substantially the same structure as the native material. The study of the conditions under which such fibrils are formed *in vitro* is likely to be of importance in the general study of fibrogenesis, on which we are engaged, and of long-chain polyelectrolytes. Broadly speaking, four types of precipitate have been found: (i) gels which contain no fibrils; (ii) fibrous precipitates of collagen induced by the addition of simple salts or *p*H changes; the detailed structure of these fibrils is very similar to that of native collagen; (iii) fibrous precipitates induced by the use of complex molecules (anions), such as acid glycoprotein, chondroitin sulphate, etc.; the periodicity of such fibrils is not characteristic of native collagen and ranges from 2000 to 3000 A.; (iv) if small amounts of adenosine triphosphate are added to collagen solutions, not fibrils but segments are produced of similar periodicity to the fibrils of (iii).

F. O. Schmitt's laboratory has been largely concerned in the study of types (iii) and (iv), and F. C. Kelly has recently carried out interesting experiments on the interrelationships of various precipitates. Collagen molecules in acid solution at a *p*H of ~ 3 are probably random coils with a net positive charge arising from the excess of charged arginine, histidine and lysine groups over the negative carboxyl groups of glutamic and aspartic acids. As the *p*H rises to that at which precipitation may occur, it is likely that the molecules become helically coiled, under which condition roughly one charge of each sign exists per turn of each chain of the helix.

Mr. F. Booth and I have been investigating theoretically the conditions for the precipitation of long, thin, charged molecules, and it turns out that collision dynamics may be ignored and the problem investigated by a study of van der Waals and electrostatic interactions. At the present time, the helical model referred to above in which positive and negative charges alternate along the length of the helix has not been completely worked out, but it is clear that the step-wise distribution of charge may be important. More detailed work has been done on the interaction of long thin molecules with a smooth charge distribution. If molecules attract each other in all relative positions, the resulting precipitate would have no ordered structure. On the other hand, if attractive forces exist only when the molecules are parallel to each other, the precipitate would be fibrous. Van der Waals forces will always tend to orientate neighbouring molecules so as to bring them parallel.

An interesting feature of the models already studied is that, when the net force is attractive, there will be a turning moment tending to align the molecules, and this moment increases rapidly as the angle between the molecules decreases. I have recently shown experimentally that collagen fibrils of normal characteristics may be produced by nothing more complicated than a change of *p*H. This adds weight to the argument that collagen precipitates appear to be controlled by the van der Waals and electrostatic interactions of neighbouring molecules. Thus a rise of *p*H reduces the net positive charge to the point where overall attraction and precipitation result. Precipitation by salt arises from drastically reduced Coulomb interaction, due to increased screening by the ionic double layer.

In the more complex instances of fibrous-long-spacing and segment-long-spacing precipitates, we must be careful not to assert that the interaction results in a purely collagenous precipitate. This seems highly unlikely, and the evidence at present suggests that these systems are complexes of collagen with an interacting anion.

It seems significant that structure in great variety exists in all these precipitates, and it is not un-

likely that the phenomenon of structure arises from some as yet unknown peculiarity of collagen. The details of structure depend more on the nature and stereochemistry of the interacting molecules.

In concluding this account it is a pleasure to pay tribute to the enthusiastic efforts of the colleagues whose work I have largely described, and the invaluable support of the technical staff of the laboratory.

TREE GROWTH ON ACID SOIL

A JOINT session of Sections K (Botany) and K* (Forestry) of the British Association devoted the whole day at Oxford on September 7 to a symposium on "The Interactions between Acid Soils and Forest Trees". Biologists whose joint research interests covered a wide variety of subjects combined with practical foresters in an attempt to solve, or at least to restate in simpler terms, the problems of establishment and maintenance of forests on heathy and peaty soils.

Mr. M. V. Laurie, chief research officer of the Forestry Commission, opened the discussion by presenting the forester's point of view, based upon the thirty-five years experience of the Commission. He pointed out that much of the land at present available for reafforestation in Britain is acid and that two classes of problems therefore exist. First, the problems concerned with the effects of acid soil on the establishment and growth of trees ; and secondly, those concerned with the effects of the trees themselves upon soil fertility. Soil is the working capital of the forester and he has therefore a duty of maintaining it, undiminished in productivity, in perpetuity while producing the right crop of the highest quality.

On the land available, the solution of the problems of tree establishment consumed much of the early effort of the Commission. Preliminary treatments such as ploughing, draining and the application of fertilizers are effective on many sites ; but the degree to which they are valuable and the magnitude of the improvement in tree establishment that they produce are not easily predictable. The full interpretation of the results of early successes and failures demands not only long-term experiments on a large scale but also the co-operation of experts. The effectiveness of mixtures of Sitka spruce and Japanese larch or pine, the beneficial effects of broom on spruce growth and the universally adverse effect of heather on all tree species must be interpreted by ecological experimentation. The stimulation of many species by phosphate on sites where lime and nitrogenous fertilizers are ineffective requires the co-operation of physiologists and microbiologists for explanation. Microbiologists, too, must assist in helping to determine the rival claims of organic manures and composts as against balanced applications of artificials. All these problems concerned with forest establishment are in the process of being solved with the help of specialists, but the long-term question of fundamental importance—the effect of trees on the soil—remains.

The vigorous forests of young conifers which have been established are undoubtedly changing the soil. In the place of the much modified heath soils, acid woodland mor with a deep layer of needles is being produced. It is held by many ecologists that mor conditions lead to serious soil degeneration. Two points must be considered in this regard. First and foremost, the demand for timber is mainly a demand for pine and spruce. A supply of poor-quality hardwood, even if such a crop prevented mor formation, would not be economic. Secondly, it would seem that what we believe to be natural northern coniferous forest exists almost exclusively on mor or podsolized soils as a self-regenerating natural forest.

Dr. G. W. Dimbleby, of the Department of Forestry, Oxford, was opposed to the view that mor conditions should be allowed to develop in newly established forests. He stated that podsol and its attendant raw humus layer form an undesirable medium for the growth of forest in Britain and it is, moreover, avoidable. Dr. Dimbleby described the work of a research team in Oxford which had undertaken fundamental research on many aspects of tree nutrition. The team concentrated its attention on areas in Yorkshire, where tree establishment on high-level heather moors is beset with great difficulty. It has often been stated that these moors are a natural ecological climax. This view has been shown to be erroneous by the study of the soil surfaces and profiles beneath bronze-age earthworks. On the surface below these artificial mounds, charcoal of birch and oak is found on the sites of hearths. The soil surface is rich in the pollen of hazel, oak, lime and alder and lacking in heather pollen. The soil profile below is typical of a brown forest mull. Indeed, the podsol profile of the heath goes over the top of the earthworks and is undoubtedly of more recent development. The vegetation and the soil have undergone a change from mixed deciduous forest on brown earth to heath on podsol since bronze-age times, and evidence suggests that man's activity in cutting, burning and grazing is the cause. Nowadays, when burning and grazing are prevented, birch and pine may seed themselves into the heaths. Of these, birch becomes established, its roots break through the iron-pan of the podsol and its leaf litter and the detritus from associated plants convert heather mor to mild humus so that a forest soil with a vigorous fauna becomes established. Pine, on the other hand, fails to break the pan, and the mor conditions and bad drainage are exaggerated, and acidity and poor nutrient status are maintained.

The effects of birch in this sequence are essentially similar to the effects of soil treatment. Ploughing causes breakage of the pan and improves drainage and aeration. Mulching and manuring temporarily simulate the beneficial nutritional status of mull. If pine is planted this improvement is reversed ; and leaching and podsolization develop with the accumulation of deep needle litter in which vast stores of minerals, which would otherwise be available, are locked.

The beneficial effects of birch and other species under which brown earth develops can probably be partly interpreted in terms of the behaviour of their litter during breakdown. The cellulose in the walls of the mesophyll of heather and mor-producing species is protected from breakdown by a resistant layer of a tannin–protein complex which is laid down upon them as they die. This is usually lacking in species not producing mor and, indeed, admixtures of birch litter or extracts of it can be used to stimulate breakdown of mor.

Prof. L. G. Romell, of Sweden, who was guest speaker, discussed the formation of mor. He pointed out that the humus turnover in mull soils is not faster than that in mor, and indeed the amount of organic matter is often higher in them. Moreover, when mor is isolated and stored, loss of organic

matter and release of available nitrogen occur. The form of the curves relating these changes with time of storage is such as would be expected when a material high in nitrogen content is available for decomposition. The application of lime to decomposing mor in storage increases the rate of loss of organic matter but decreases the rate of release of available nitrogen. The immobilization of nitrogen in the presence of lime is due in part to reaction of ammonia with quinoid complexes in the humic matter.

The examination of a mor profile shows it to be characterized by a great concentration of roots, mycorrhizas and mycelia. Acidity is not, however, a diagnostic character of mor because mull may have a similar *p*H range. In beech soils, mor develops inevitably as the forest ages, so that liming and forest treatment cannot arrest the change from mull to mor. In the time of P. E. Müller (who first used the terms 'mor' and 'mull' in their present sense) mor was widespread in Denmark; now it is rare. The old beech stands are gone, and in the young forests mull exists in its stead. Similar parallelisms between mor development and the age of stands are found throughout the spruce forests of Sweden.

The factors affecting the development of mor have been analysed by ecological experiment. Addition of nitrogenous manures causes stimulation of ground flora and tree growth on mor soil. Other fertilizers have little effect. The death of trees from natural causes or felling is followed by a quick response, and dense ground flora develops. Trenching experiments where roots are cut have similar effects, producing dense ground flora, high nitrogen and phosphorus content of vegetation and the disappearance of the mor profile. All these experiments, taken in conjunction with estimates of the release of available nitrogen during storage, indicate that the prime factor in mor formation is nitrogen starvation. The intensification of competition for nitrogen by roots and mycelia as a stand ages leads to formation of mor, decrease of ground vegetation and slow growth of trees. Such a view of the mechanism of formation of mor, although it runs counter to many accepted teachings, explains more closely the ecological and experimental data.

The wide experience of Prof. Romell and the intensive researches of the soil nutritional team described by Dr. Dimbleby seemed, therefore, in full agreement concerning the relative productivity of mor and mull and the need to prevent development of mor. Suitable sylvicultural measures could prevent its development, and these were dealt with in subsequent discussion.

Dr. S. D. Garrett described work done at the Botany School, Cambridge, on the microbiology of acid soils with respect to soil-borne disease. He took two examples where there is an apparent correlation between *p*H and intensity of disease. Both in the case of *Fomes annosus* butt-rot of pines and spruces and in *Pythium* disease of seedling roots, disease is less intense in acid than in alkaline soils. The diminution of the damage caused by *Fomes* on acid soils can be ascribed to an effect of *p*H upon the soil micro-flora rather than upon the pathogen or host. *Fomes* spreads inside and along the surfaces of living roots and passes from host to host by root contact. Rapid advance along the root-surface, leading to widespread disease, is possible on alkaline soils, because *Trichoderma viride*, a virulent antagonist of *Fomes*, is absent. On acid soil only an internal spread of *Fomes* is possible, and the disease is of less importance. *Pythium* diseases of seedling conifers are also less intense on acid soils and in this respect they contrast with similar diseases of crucifers. The effect of *p*H may here be ascribed to a direct effect on the host and not upon the pathogen. The ecological optimum of conifers lies on the acid side of neutrality, so that they resist the disease on acid soils.

Although these examples illustrating the causes of increase or decrease of virulence with soil conditions appear simple when the final conclusions are reached, they are based upon wide ecological surveys in which apparent correlations, many of them spuriously giving the impression of causation, are observed. Such observations must be followed by detailed controlled plot and laboratory experiments.

Dr. J. L. Harley, of the Department of Botany, Oxford, also discussed soil microbiology in an attempt to fit work on the physiology of mycorrhiza done in Oxford into its ecological perspective. The concentration of roots and mycelia in the mor profile described by Prof. Romell is easily observable in beechwoods in Britain. Estimates of weights of absorbing roots in various horizons of mull and mor confirm the intense colonization of the *F* and *H* layers of the latter. These roots are mainly mycorrhizas and are completely clothed in a tissue of fungus through which all nutrients entering the tree must pass. Observations on spruces by Wilde in America and on beech in Oxford show that similar subsurface aggregation of roots can be induced by treating even highly nutritive soils with excessive surface layers of organic material. Following the aggregation of roots, starvation symptoms can develop. The conditions in which mycorrhizal roots show their greatest development are these conditions of intense competition for nutrients. It is possible with beech, as has been shown in Sweden and America for pine and spruce, to vary the intensity of mycorrhizal infection by arranging a deficient supply of nutrients in the soil while ensuring rapid photosynthesis and carbohydrate production. The ecological conditions of intense mycorrhizal formation are those in which growth-rate may be small. Indeed, an inverse correlation of growth and mycorrhizal infection is often observed in natural conditions. Such correlations provide no evidence concerning the functioning of mycorrhizal organs, which must be sought in laboratory experiments.

If conventional physiological methods of studying nutrient absorption by roots are applied to mycorrhizal roots, it is readily shown that they accumulate salts in their tissues. The rates of accumulation of phosphate, ammonia and the alkali metals are rapid, and the mechanism of absorption is linked with metabolic activity. The rate is very sensitive to temperature, oxygen supply and the presence of metabolic poisons. It is very rapid in oxygen concentrations approximating to that in air and, in some conditions, is closely correlated with oxygen consumption in respiration. Comparisons of the rate of absorption of minerals by mycorrhizal and non-mycorrhizal roots of beech and pine show greater rates of accumulation into mycorrhizas of all salts tested. The mycorrhizas may therefore compete on more level terms than uninfected roots with the mycelia and other roots in the soil. The primary destination of the salts absorbed is into the fungus, and phosphate in particular accumulates in the fungal layer at first, so that during absorption the supply

of phosphate to the host tissue is no greater in mycorrhizal than non-mycorrhizal roots.

Two mechanisms have been studied by which the ions trapped by the mycorrhizal sheath of fungus can be made available to the host. First, it has been shown by direct observation and photographic record that beech mycorrhizas have a life-period of about eight months only. Hence there is a periodic release of mineral-rich organic matter into the actual rooting region of the host. Secondly, there is in the tissues a metabolic turnover of phosphate, sensitive to oxygen and temperature, the net result of which is the movement of phosphate from fungus to host during periods when the rate of uptake is low. Hence, during periods of rapid release of minerals from newly fallen litter, nutrients may be trapped and accumulated in the fungal layer of mycorrhizal roots and, in the subsequent periods of slower mineral release, phosphate and perhaps other minerals are passed to the host. Laboratory physiological experiments, therefore, are providing a credible picture of the functioning of mycorrhizas in ecological conditions.

Dr. L. Leyton, of the Oxford Forestry Department, described detailed work on mineral nutrition of conifers which has been carried out in the same areas as that described by Dr. Dimbleby. His description of the soil profiles of sitka spruce forest in Yorkshire was exactly comparable with that of previous speakers, and his analysis of mor and mull again emphasized the deficiencies of available soil nutrients, especially of nitrogen. Significant increases of growth were obtained by the application of nitrogenous manures, and little increase was obtained with phosphate. Dr. Leyton described the technique of analysis of foliage to determine the nutrient status and mineral deficiencies of the site. On untreated soils, needle weight and nitrogen content are positively correlated, and the effects of the use of nitrogen fertilizers, removal of heather and mulching owe their efficacy in promotion of growth to increase of available nitrogen. Application of phosphate only affords a secondary stimulation.

The humus layer contains as much as 2 per cent of dry weight as nitrogen, so reasons were sought as to why this is not made available. Calcium deficiency is very marked, and it is possible that microbiological activity is limited by this factor. On the other hand, the soils in question are often water-logged in winter and dried out in summer. This adverse water régime may be counteracted by mulching, which results in a rapid increase of microbiological activity in the rooting layer.

The method of needle analysis has proved very valuable in this study, for it can be used to predict as well as to follow the effects of soil treatments on trees of any size. In all cases where treatments improve growth, an immediate response in needle colour and weight preceeds increased growth. The needles of the following year's crop are laid down in the buds of the current year, so that although immediate growth response to treatment is not observable, the constitution of the needles provides a satisfactory basis of prediction of growth in the future.

With these set papers as a background, the whole subject was discussed. Prof. Romell pointed out that the effects of liming are complicated because of the stimulation of white rot fungi above *p*H 4·5, and the lack of effect of lime treatments mentioned by Mr. Laurie and others might be explained by the trapping of nutrients by them. He asked about the stimulation of turnover in mor by hardwood litter, and Dr. Dimbleby and Mr. Murphy stated that it can occur and is associated with increase of faunal activity. Dr. Dimbleby spoke strongly in favour of developing stands of mixed tree species, but Mr. Hiley emphasized that adequate thinning of conifers would encourage ground flora, the detritus of which would have the required effect of reversing the tendency to formation of mor. He also described how mor develops under old oak stands and how felling of such stands and replanting with conifers may give rise to mull with an *Oxalis* and *Rubus* ground-flora. Dr. Harley pointed out that such a change might be the result of felling and planting rather than an effect of the conifers themselves. Mr. Laurie showed that there are still untouched problems concerning the factors leading to the aggregation of roots so characteristic of mor. He asked if some of the known effects of mycorrhizal and other fungi on the growth and branching of roots could be a factor in the process. Dr. Harley and Dr. Leyton suggested that a study of oxygen supply and water supply in the surface soil layers would perhaps be a better first approach to these problems, as both these factors greatly affect root-growth and activity. Prof. W. H. Pearsall, who was in the chair, commented that although there was clearly evidence that many of those present disagreed on various grounds with the planting of conifers on many sites in Great Britain, no battle had developed on this subject. The first problem in reafforestation, he said, is to make difficult sites productive and then to ensure that their soil tends to change towards mull rather than away from it. Britain is a region of brown forest soils, and present policy should be to re-establish them. No doubt it was felt that such a discussion would lead the meeting away from biology into economics, for in spite of this challenge no battle developed.

The meeting was a highly successful discussion of a most important subject, and indeed was a hard but valuable day's work for those who took part.

ANIMAL BEHAVIOUR

AT the recent meeting of the British Association in Oxford, Sections D (Zoology) and J (Psychology) held a joint discussion on "Animal Behaviour", which was attended by some four hundred members. The discussion dealt with the study of animal behaviour as it is practised by Konrad Lorenz and other zoologists who follow his lead. These investigators usually refer to themselves as ethologists, and the first two papers presented some of the features of their method, some of their findings, and some of their theoretical concepts. The third paper was given by a psychologist, who considered some of the relations between ethology and psychology.

Dr. N. Tinbergen (Department of Zoology and Comparative Anatomy, University of Oxford) opened the discussion with a paper on the bearing of the ethological study of animal behaviour on the study of human behaviour. He began by stressing the need for restraint in making comparisons between animals and men, and by saying that, in his view, the importance of Lorenz's work, and of ethology generally, lies not so much in any new theory of behaviour that has been put forward as in its particular type of approach. This approach sets great

store on careful observation and description of the behaviour being studied; on qualitative analysis as a prerequisite of quantitative measurement; on study of the whole behaviour in question, not merely of one particular part or phase or aspect; and on the preservation of a proper balance between study of the causation of behaviour and study of its evolution and survival value.

He then discussed certain aspects of the study of inborn behaviour—behaviour "as it appears before conditioning and other learning processes set in". Each animal has a limited repertory of movements, each of which is characterized both by its causes (internal and external) and by its overt motor-pattern. Ethology investigates both characteristics. In connexion with the begging response of the herring gull chick, for example, it has been shown, in relation to the stimuli, that, in eliciting the begging response, the red patch on the parent's beak (or a similar patch on a cardboard dummy) is of great importance, and that here, as elsewhere, "only very few of the receivable outside messages are influential"; and it has also been shown, in relation to the response, that it is an innate motor-pattern, since it is exhibited before the chick can have practised it and is non-modifiable and difficult to condition.

Similar studies of human behaviour are far more difficult, and often inadmissible. Yet there are perhaps indications of inborn mechanisms—specific responses to specific stimuli—in certain anti-predator reactions of human beings, in the infant's reaction to the mother's smile, and in other behaviour patterns.

Dr. Tinbergen also referred to ethological work on motivation. The motivation expressed in a movement can be recognized, he said, by the form of the movement, by the effect of the movement and by the specific factors attending its occurrence. Often there is mixed or ambivalent motivation, as in the alternating movements of attack and escape to be seen in animals and in boxers. There are also 'displacement activities'. These are patterns of behaviour that "do not belong to the motor pattern of the instinct that is activated at the moment of observation"; they are expressions of some other instinctive drive, and they act as outlets for a surplus of motivation, the discharge of which through the normal paths is in some way prevented—as when the aroused but baulked fighting instinct of domestic cocks finds an outlet in food-pecking movements. Although displacement activities are by no means rare in man, and may well have an important bearing on neurotic behaviour, they are not as easily identified in man as in animals, because, whereas a true displacement activity is always an innate pattern, in human behaviour learned patterns, like lighting a cigarette, or handling keys or handkerchief, also often function as outlets for displaced motivation.

In the second paper, Dr. R. A. Hinde (Ornithological Field Station, Department of Zoology, University of Cambridge) sketched five of the ways in which learning modifies inborn behaviour—"behaviour which appears without previous specific practice", as, for example, the 'mobbing' response of chaffinches to owls, which is elicited by a stuffed tawny owl in young chaffinches that have never seen an owl.

First, learning brings about changes in the stimuli that elicit a particular inborn response. Many studies, such as those of Wallace Craig and of W. H. Thorpe and F. G. W. Jones, indicate the importance that early experience may have in the development of behaviour that appears at first sight to be inborn. A particularly dramatic example of the effect of learning on the stimuli eliciting a response is provided by 'imprinting', as when the greylag gosling follows, and behaves towards, the first relatively large moving object that it sees as though it were its parent. In Dr. Hinde's view—and in this he differed from Lorenz—this process is probably not fundamentally different from other forms of learning.

Secondly, learning affects the stimuli which "guide the orientation of behaviour". Here only a few cases have been analysed; but, to take one example, Tinbergen has shown that the digger wasp makes a 'locality study' on leaving its nest, and learns the position of the nest in relation to certain landmarks (a ring of pine cones in one experiment); with the result that, if the landmarks are moved, the wasp repeatedly goes to the new position that they indicate, not to the real nest.

Thirdly, learning sometimes changes the motor-pattern of inborn behaviour. Such modification (except in the intensity of the response) is rare, if not impossible, in the inborn movements used by animals in locomotion, preparing food, nest-building, fighting, courting, and so on; but it occurs extensively in the movements underlying vocal utterances. The bullfinch, for example, can be taught to add whole new tunes to its repertoire.

Fourthly, there is the question of changes, due to learning, in consummatory stimuli—the stimuli to which the animal is particularly responsive while carrying out the instinctive or consummatory act in an inborn pattern of behaviour. Little is yet known about this kind of modification, but it would seem that it must be involved in 'imprinting', and must also be related to 'secondary reinforcement' as understood by Hullian learning-theorists.

Fifthly, Dr. Hinde referred to changes in responsiveness to a constant stimulus, and, particularly, to his work on the waning of the 'mobbing' response in adult chaffinches confronted with a stuffed predator. It has been shown, he said, that underlying this waning of responsiveness there are certainly two processes—one more or less independent of the stimulus and subject to fairly rapid recovery, the other specific to the stimulus and producing a more or less permanent decrement—and probably a third, which is linked to the stimulus and subject to rapid recovery.

In the last part of his paper, Dr. Hinde directed attention to three aspects of behaviour, which, he said, "are brought home rather more forcibly to the field ethologist than they are to the laboratory psychologist". These were: (*a*) that the nature, as well as the complexity, of the things an animal can learn seem often to be determined by its constitution; (*b*) that learning often occurs in animals without any of the conventional rewards, such as food, water or escape from pain, and in circumstances where "the perception of a particular situation seems to act as a reinforcing agent"; and (*c*) that animals are curious, and the analysis of this curiosity is "one of the most urgent problems awaiting both ethologist and psychologist".

To Prof. R. Knight (Department of Psychology, University of Aberdeen) had been assigned the task of discussing aspects of ethology that seemed of special interest to psychologists. He began by referring to matters about which ethologists and psychologists are agreed. Thus they both accept the

comparative study of behaviour, including the comparison of animal and human behaviour, as possible and useful. In 1951 Dr. Tinbergen wrote of "the almost universal misconception that the causes of man's behaviour are qualitatively different from the causes of animal behaviour", and no doubt this belief still has its adherents; but psychologists, no less than zoologists, may now be taken to accept the view that the comparative method is as appropriate in the study of behaviour as in anatomy, embryology, physiology or biochemistry. Again, both psychologists and ethologists proceed on the principle that behaviour, in Dr. Hinde's words, "is mediated by the nervous system, and every particular pattern of behaviour is mediated by a particular nervous mechanism or pattern of nervous activity".

The main differences, Prof. Knight suggested, between ethologists and many psychologists, especially American psychologists, relate to theory. Some of the difficulties that psychologists see in Lorenz's theoretical system have been expressed by D. O. Hebb and (though he is not himself a psychologist) by D. S. Lehrman, of the American Museum of Natural History.

Three of these difficulties may be put in the form of questions. First: Is the ethologists' use of the comparative method sufficiently strict? It would appear that Lorenz and Dr. Tinbergen do not always confine their comparisons to what is truly homologous, but are sometimes apt to assume that functionally similar behaviour patterns must be caused by fundamentally similar mechanisms; whereas in fact there is plenty of evidence that, at different evolutionary levels, functionally similar behaviour patterns often depend on mechanisms that are very different in origin and fundamental structure.

Second: Are the ethologists' criteria of innateness satisfactory? They ascribe innateness to all behaviour that appears without previous specific practice, and, in particular, to any behaviour pattern that appears in animals that have been raised in isolation from fellow-members of their species and prevented from performing the particular pattern in question. But, as Lehrman has pointed out, an animal isolated from others and prevented from practising a particular behaviour pattern is "not necessarily isolated from the effects of processes and events which contribute to the development of the particular behaviour pattern"; and cases (for example, the nest-building of pregnant rats) can be given of behaviour which satisfies the ethologists' criteria of innateness but is demonstrably dependent on the animals' previous experience.

Third: Are the ethologists on the wrong tack in looking for unitary, autonomously developing behaviour patterns? For heuristic and other reasons, many psychologists are averse from an approach which regards the development of behaviour as involving the maturation of specific behaviour patterns and of specific mechanisms underlying them. They prefer an approach which, while acknowledging the importance of the physical growth of various structures, regards the development of behaviour as a process in which at each stage new patterns of nervous activity, and consequently new patterns of behaviour, emerge from interaction within the organism and between the organism and its environment.

In the subsequent discussion, Dr. W. H. Thorpe (Department of Zoology, University of Cambridge) said that, in his view, Lorenz's theoretical scheme has greatly stimulated, clarified and simplified the study of behaviour. He referred particularly to its concept of the 'innate releasing mechanism', to its division of behaviour into flexible appetitive behaviour and the relatively rigid consummatory act, and to its distinction between 'directing' and 'releasing' stimuli. He also said that, although Lorenz's theory does take considerable account of innate or inborn behaviour, it is not anti-learning; indeed, it not only accepts the usual kinds of learning but also adds another—'imprinting'. Prof. C. W. Valentine (formerly of the Department of Education, University of Birmingham) said he wished to make it clear that not all psychologists, particularly in Great Britain, are unsympathetic to the idea of instinctive drives and inborn patterns of behaviour. Although the word 'instinct' has for many years been under a ban in American psychology, it is now beginning to reappear, and innate impulses and actions, as well as other constitutional factors, are receiving increasing attention in recent American work in educational and developmental psychology. Prof. T. H. Pear (formerly of the Department of Psychology, University of Manchester) welcomed ethology and its experimental field-studies of birds and a variety of other animals as helping to "break the domination of psychology by American laboratory studies of the rat"; but, while psychologists are right, he said, to be interested in animal behaviour, they must not let this interest so obsess them that they neglect the study of "civilized and sophisticated men and women".

REX KNIGHT

PAUL SABATIER, 1854–1941

By PROF. J. R. PARTINGTON, M.B.E.

PAUL SABATIER, the centenary of whose birth fell on November 5, was born of a modest family in Carcassone in 1854. In 1874 he passed high on the lists in the entrance examinations for the École Polytechnique and the École Normale Supérieure. His place (fourth) on the list of the Normale was higher and he chose to go there. In 1877 he was top of the list of graduates in his class. After a year as professor at the Lycée at Nimes, he had the good fortune to become assistant to Berthelot at the Collège de France, where he took his doctorate in 1880 with a thesis on the metallic sulphides. After a year at Bordeaux, he became assistant professor of physics, and in 1883 of chemistry, at Toulouse, becoming professor of chemistry there in 1884 at the early age of thirty. In Toulouse, in spite of an offer to succeed Moissan at the Sorbonne in 1908, Sabatier stayed for the rest of his life, and died there on August 14, 1941, aged eighty-seven*. He became dean of the faculty of science in 1905. He was an excellent and very popular teacher, and long after his retirement, in fact nearly to the end of his life, he continued to lecture. He became *correspondant* of the Academy of Sciences in 1901 and the first non-resident member in 1913. He was Nobel laureate in chemistry in 1912, Davy medallist of the Royal Society in 1912 and foreign member of the Society in 1918, doctor *honoris causa* of the University of

* *C.R. Acad. Sci., Paris*, **213**, 281 (1941); *Obituary Notices of Fellows of the Royal Society*, **4**, 63 (1942–44); *J. Amer. Chem. Soc.*, **66**, 1615 (1944).

Pennsylvania in 1926, and Franklin medallist in 1933.

Sabatier's early work was in physical and inorganic chemistry, some of it in collaboration with his pupil, Jean Baptist Senderens. He first obtained pure hydrogen disulphide by vacuum distillation in 1886, discovered new metallic nitrides, and studied nitrosodisulphonic acid. He also made thermochemical measurements. His most famous work, begun in 1897 and occupying him for thirty years, was a study of the applications of heterogeneous catalysis in organic chemistry, of which he published a summary in his book, "La Catalyse en Chimie Organique", 1912. Although platinum had long been used as a contact mass, and the associated Dutch chemists in 1796 had found that alcohol vapour when passed over heated alumina is decomposed into ethylene and steam, little or no application of catalysis in organic reactions had been made. Sabatier became interested in this field by Mond's work on nickel carbonyl, and he used nickel, as well as other finely divided metals such as copper, as catalysts.

At that time there were two theories of heterogeneous catalysis. Faraday in 1833 had suggested a physical theory that one or more of the reacting gases was condensed by attraction on the surface of the metal. William Charles Henry in 1836 and de la Rive in 1838 had proposed a chemical theory that intermediate compounds, for example, oxides of metals, were formed and decomposed. Sabatier soon proved that the specific action of catalysts strongly supports the chemical theory. He showed that different contact masses produce different reactions. Formic acid vapour passed over heated zinc oxide gives only hydrogen and carbon dioxide, but when passed over heated titanium oxide it gives only steam and carbon monoxide. Chromic oxide can act both in oxidation and in dehydrogenation and dehydration reactions. Heated alumina decomposes alcohol into ethylene and steam, metallic molybdenum and zinc oxide decompose it into acetaldehyde and hydrogen. Sabatier postulated the formation of different intermediate compounds, each with its own mode of decomposition, and he also clearly recognized that some organic reactions are reversible; and in cases where intermediate compounds cannot be isolated, there may be a production of surface compounds (chemisorption), thus linking the two theories of catalysis, the physical and chemical. Recent work has largely confirmed his views.

Sabatier's catalytic hydrogenation technique, carried out with relatively simple apparatus, was applied to the preparation of a large number of organic compounds. He clearly saw the technical importance of his work and took out several patents; but for some reason he did not extend the method to hydrogenation in the liquid phase. This was first studied by Ipatiev and led to a revolution in the fat industry by the hydrogenation of oils with a nickel catalyst.

Sabatier was responsible for opening out a new field in organic chemistry, and his clear appreciation of the importance of physical and inorganic chemistry in that branch of the science was most fruitful. The influence of his great master, Berthelot, with his wide interests, was clearly apparent in all Sabatier's work, and infused new life into organic chemistry at a time when it was becoming stereotyped.

Sabatier's personal qualities were greatly appreciated by his colleagues. Although able to lecture only in French, he was always welcome abroad. He was one of the great school of French chemists, and his contributions to the science were both extensive and important. The centenary of his birth was marked by commemorative meetings held in Toulouse during November 4–5.

OBITUARIES

Mr. J. P. Bushe-Fox, C.B.E.

Jocelyn Plunket Bushe-Fox died on October 15 at the age of seventy-four, having been ailing for some time and unable to take part in archæological affairs. Archæology had been his great interest in life and the subject of his life-work. His education at St. Paul's School, with its fine classical tradition, influenced his choice of field, and it was to Romano-British archæology that he turned, after a brief interlude in Egypt.

He was one of the ablest of the young men whom Haverfield gathered about him for the initial exploration of the Roman site at Corbridge, Northumberland, and, strongly influenced by the then recent work of James Curle at Newstead, he began the study of stratified pottery of all kinds as a criterion for dating the sites upon which it was found. His Corbridge contribution was not so weighty as those which came later, but it still remains of value to students of the site and subject.

Under the ægis of the Society of Antiquaries, his excavation of two Iron-Age sites, at Swarling and Hengistbury Head, and of the Roman town at Wroxeter (*Viroconium*), laid foundations which have often been obscured by the important superstructures built upon them and have never failed. His work has stood the test of time and the challenge of later developments remarkably well.

His largest task, however, was undertaken after the First World War, in which he served with the distinction and ability of one who came of Irish military stock. He entered the Ancient Monuments Department of H.M. Office of Works (now the Ministry of Works) and undertook on behalf of the Society of Antiquaries the excavation of the Roman site at Richborough. This was a task of unprecedented complication, involving many levels often heavily robbed. The main lines of the history of the place were sorted out in four brilliant reports, in which the most notable feature, in what may appropriately be called the Bushe-Fox tradition, was the meticulous care devoted to the stratified pottery and small objects. Structurally, the most notable achievements were the definition of the great triumphal monument and of the supply-base which preceded it and occupied the Claudian invasion bridge-head.

No other worker has nine research reports of the Society of Antiquaries to his credit; no other perhaps the genial patience and scholarly perseverance to produce their like. They mark an age, and a standard of individual effort which deserves record, admiration and respect. I. A. Richmond

Dr. Anthony L. Levy

Anthony Lewis Levy lost his life on August 21, in a mountaineering accident on Mt. Olympus in the State of Washington, after he had successfully rescued an injured companion from a glacial crevasse.

Born in Romford, Essex, in 1924, Levy attended Brentwood Grammar School, Essex, and the Imperial College of Science and Technology, London, receivin

his B.Sc. in 1944 and his doctorate in 1947. During the Second World War he worked on the chemistry of penicillin, research which led him to the development of methods for the stepwise degradation and synthesis of peptides. After the War, he continued his research at the Imperial College, London, under the direction of Sir Ian Heilbron and Dr. A. H. Cook, and in 1949 he was awarded a Rockefeller Foundation fellowship to work under Prof. K. Linderstrøm-Lang at the Carlsberg Laboratories, Copenhagen. From 1951 until his death he was an invaluable member of the Hormone Research Laboratory at the University of California, Berkeley. During this period, he developed a new solvent system for the two-dimensional chromatography of amino-acids on buffered papers, which has been widely adopted. His recent discovery of a new method for the quantitative microanalysis of amino-acids in proteins and peptides represents an outstanding advance in the field, and had already gained him world-wide recognition. Just before his death, he was engaged in research involving the structure and possible synthesis of adrenocorticotrophic hormone.

His former teacher, Sir Ian Heilbron, in a letter of sympathy to Levy's mother, wrote, "His most recent work was quite outstandingly brilliant, and Science, the world over, is the poorer by his passing". But the loss of this young biochemist is measured in terms not only of science, but also of humanity. His quick enthusiasm, his zest for life, and his warm generosity established him firmly in the affections of all who knew him, and he is sincerely mourned by all his colleagues and friends. C. H. Li

NEWS and VIEWS

Jôkichi Takamine (1854–1922)

Jôkichi Takamine, the discoverer of the active principle in chemically pure form of the suprarenal glands, was born in Takaoka, Japan, a century ago on November 3, 1854. He was educated at Osaka, Kyoto and Tokyo and, after graduating in technology at the Imperial University of Japan in 1879, went with a government scholarship to the University of Glasgow, studying the chemistry of brewing at Anderson's College. On his return to Japan he was appointed chief of the Chemistry Division in the Department of Agriculture and Commerce, but resigned two years later to devote himself to industry. He developed the first superphosphate works in Japan, the Tokyo Artificial Fertilizer Company, and discovered the starch-digesting enzyme takadiastase. The remainder of his career was spent mainly in the United States where, in addition to his scientific activities, he wielded considerable political influence, being recognized as the unofficial representative of Japan. Joining Parke, Davis and Co., of Detroit and New York, in 1898, he began his search for the active principle of the suprarenal glands, a task which had been unsuccessfully attempted by some of the world's leading physiological chemists, and in 1901 he succeeded in obtaining adrenalin (as he called it) in stable and pure crystalline form. Takamine played a prominent part in developing Japanese industry and technical education and in establishing the Imperial Research Institute. A firm believer in the role of medicine as a civilizing force in Asiatic countries, he strove to promote better understanding between the country of his birth and that of his adoption. Recipient of many honours and a cultured, public-spirited and charming personality, Takamine died in New York City on July 22, 1922, at the age of sixty-eight.

Conference of Czechoslovak Archæologists

The "Ninth Working Conference of Czechoslovak Archæologists", organized in Prague during September 25–30 by the Czechoslovak Academy of Sciences, included visitors from Britain, East and West Germany, Hungary, Poland and the U.S.S.R., as well as Bohemia, Moravia and Slovakia, and the themes were treated from a general Central European point of view. (Before 1945, Czech archæology had tended to be rather excessively Bohemian, partly of course because Moravia and Slovakia were far less well explored.) The central theme was the chronology of early Slav settlement, as determined largely by pottery. Poulik from Moravia opened with an able restatement of the traditional thesis of Pič, adjusted to accommodate the enormously augmented data, according to which early Slav pottery, and therefore its makers, is to be derived from the Lusatian urnfields of the Late Bronze Age. But this thesis was stringently criticized in a lively debate. The visitors were also able to see several early Slav oppida, excavated with superb technical skill so as to disclose the remarkable wooden constructions in their ramparts and the plans of wooden houses enclosed therein, as well as the encampment of mammoth hunters at Pavlov, near Dolní Věstonice, later in date than the classic Gravettian site, but, like it, yielding clear hut plans, a rich industry in flint, bone, antler and ivory (not distinctively Magdalenian in character) and interesting art objects. They also visited the new archæological institute established at Nitra by the Slovak Academy of Sciences; the institute is well equipped, and already stocked with a wealth of relics derived from scientific excavations in this rich metalliferous region that had previously been represented in the archæological record only by stray finds.

Rumford Bicentenary: Celebrations in Boston

The Rumford bicentennial issue of the *Proceedings of the American Academy of Sciences and Arts* (**82**, No. 7, 249; December 1953) is the complete record of the scientific and biographical papers presented at the symposium which marked the two hundredth anniversary of the birth of Benjamin Thompson, Count Rumford, and which was held at the Academy in Boston during March 26–28, 1953 (see *Nature*, **170**, 954 (1952); **171**, 538, 540 and 947 (1953)). In the introductory article by Harlow Shapley, chairman of the Rumford Bicentennial Committee, the celebrations are described and the illustrated bill of fare of the birthday banquet, which was compiled by Prof. Sanborn C. Brown, is reproduced. Prof. Brown also directed the preparation of the various models of the inventions and contrivances of Count Rumford which were on exhibit and delivered the Rumford Bicentennial Lecture, the text of which is included in the bicentennial issue and which also appears in

American Scientist (42, 113; January 1954). The texts of the speeches made at the presentations of the Rumford Medals to Peter Debye, Norman F. Ramsey and Lars Onsager follow, and then the papers delivered at the three symposia on recent developments in thermodynamics, in atomic spectroscopy and in nuclear physics. These include articles by P. W. Bridgman on thermodynamics, Sir Alfred Egerton on the management of flame, Sir Francis Simon on helium and the range of stability of the solid state, E. M. Purcell on line spectra in radio astronomy, M. Siegbahn on nuclear spectroscopy, and V. F. Weisskopf on phase transitions in atomic nuclei.

National Central Library: Report for 1953–54

The thirty-eighth annual report of the Executive Committee of the National Central Library, covering the year ended February 28, 1954 (pp. 28; from the Library, London), records an increase in the Treasury grant-in-aid from £31,250 to £32,000. In the reconstruction of the Library, of an expenditure of about £105,626, £95,495 had fallen on the War Damage Commission and the Board of Trade. The library stock increased during the year by 4,423 (of which 2,472 were by purchase) to about 141,000. Applications received for loans from or through the library decreased from 100,049 in 1952–53 to 93,653, of which 71·71 per cent were successfully handled (71·21 per cent in 1952–53); total issues were 95,626 volumes, of which 17,285 were to university libraries, 10,307 to special outlier libraries, 5,845 to government departments, 5,278 to industrial and research organizations, and 14,641 to adult classes, 10,658 of these last-named being issued through adult class organizations. In the regional library systems 395 municipal, 56 county, 20 university and 84 special libraries are now co-operating, and loans totalled 169,925 within the systems and 26,689 outside them. Taking the view that membership by every public and county library of a regional system is essential to the structure of national interlending, the Executive Committee has adopted the principle that no public or county library shall be able to use the inter-loan services of the Library except as a member of its appropriate regional system. Although loans to university libraries were 755 less than those of the previous year, 24,072 books were lent by university libraries compared with 23,905 in 1952–53. Loans to and from foreign libraries again increased: 2,531 volumes were lent to forty-one countries and 1,158 borrowed from nineteen countries, France continuing to be the only country lending considerably more than it borrows and coming second to Germany as a lender of books to Britain. The Outlier Union Catalogue of books expanded faster than in recent years, and considerable progress was made in compiling the Union Catalogue of printed material in the Russian language in the libraries of the United Kingdom.

Social Problems of Handicapped Children

According to official estimates, there must be between 350,000 and 500,000 handicapped children of school age in England and Wales. All these children require special education or treatment because of some mental or physical disability. Partly because there is no awareness of the size of the problem, few members of the general public realize the difficulties that have to be faced by these children and their parents. They do not know that there are many active voluntary organizations working in this field, while even these organizations themselves are sometimes unaware that their good work is perhaps being duplicated somewhere else. To present the problem of handicapped children as a whole, Mrs. Peggy Jay has written a pamphlet called "Making our Way", which is published by the National Committee for the Defence of Children, London (pp. 12; 1954; 6*d*.). Copies can be obtained from Dr. Simon Yudkin, 23 Tillingbourne Gardens, London, N.3). The booklet shows how much has still to be done before every handicapped child can be said to be receiving all the medical attention and special education that will enable it to develop as fully and happily as its disability will allow.

Australian and New Zealand Association for the Advancement of Science: Brisbane Meeting

The report of the twenty-eighth meeting of the Australian and New Zealand Association for the Advancement of Science, held in Brisbane in May 1951, has only recently been received (Vol. 28; pp. 199. Brisbane: Government Printer, 1951). Besides Sir Kerr Grant's presidential address, "Old Questions and New Answers—Men Who Found Them", in which he reviews the contributions of Einstein, Minkowski, Planck, Rutherford, Bohr and Eddington to the concepts of space, time and atomic structure, it includes the presidential addresses to Sections, Dr. D. P. Mellor's Liversidge lecture, "Some Recent Developments in the Chemistry of Metal Complexes", and the addresses given by a Unesco delegation, which included Dr. E. B. Ford and Prof. C. H. Waddington, at two symposia on evolution. The longest of these latter addresses is that by Dr. Ford on the experimental study of evolution. Most of the presidential addresses are concerned with aspects of science of particular interest in Australia and New Zealand, though not necessarily to the extent of the review of Australian plant products given by Dr. L. H. Briggs to the Chemistry Section. Those of Dr. E. R. Walker on economic science and public policy, H. T. Parker on the scientific approach to the problems of teaching, Dr. B. J. Grieve on viruses and physiology of the host plant, Prof. R. H. Thorp on modern pharmacology and its influence on medicine and pharmacy, Dr. R. M. C. Gunn on cyclic changes in spermatogenesis in rams, and Dr. F. C. Courtice on extravascular protein and the lymphatics are at least of equal interest to scientific workers elsewhere. It is unfortunate, however, that there is not uniformity in format from year to year in reference volumes of such merit: the present volume is quarto, whereas the succeeding volume reverts to octavo. The inconvenience to the librarian and other users is obvious.

Rice Breeding and Genetics

In a monograph under the above title, K. Ramiah and M. B. V. N. Rao have given a comprehensive account of the rice plant and its utilization in India and elsewhere (Sci. Monograph No. 19, Indian Counc. Agric. Res.; pp. 360; 1953; Rs. 17.8 or 27*s*.). Although the central feature and aim of the monograph is to deal thoroughly with the breeding, genetics and cytology of rice, and to review in detail all relevant information, this volume also contains much of more general interest in that it touches upon such topics as the origin, antiquity and taxonomy of rice, the wild races and species, their botany and development, and so on. Special chapters are

devoted to the application of genetics to the improvement of the crop, methods of selection, and agricultural aspects and prospects in India. A very large section of the monograph is devoted to the genetics of rice, the inheritance of pigmentation, morphological, physiological and quantitative characters, correlations, linkage, mutations and cytology, each receiving detailed treatment. The factor of quality, as befits its importance, is discussed in its several aspects. The central aim of all this work is, of course, to improve rice production in a region where it is virtually the staple food. Here the authors make comparisons with rice production in other large-producing countries, especially those in which high yields are obtained, and conclude that much can be achieved in India by the appropriate use of fertilizers. "That India has not been able to increase her production substantially is certainly not due to lack of experimental research or scientific knowledge. The most significant reason appears to be the wide gap between research and extension. The cultivator does appreciate the value of scientific knowledge but still he cannot make use of it." The monograph is well illustrated, with some good coloured plates.

Seismology in New Zealand during 1951–53

THE readings of seismograms obtained at thirteen New Zealand observatories (including Suva, Fiji) for the periods January–March and April–June 1951 have been published for the Geophysics Division of the New Zealand Department of Scientific and Industrial Research (pp. 16 and 13, respectively. Wellington: Government Printer, 1953). Earthquake epicentres follow a familiar pattern, as they also do for 1952. In the publication dealing with "Earthquake Origins in New Zealand during 1952" (Seism. Obs. Bull., *S*-98; pp. 4 + 1 map. Wellington: Government Printer, 1953) it is stated that most of the epicentres in 1952 lay between latitudes 37° and 43° S., and there were no epicentres north-west of Karapiro. Isoseismal lines are given for the earthquake of August 28, 1952, with epicentre near Havelock North (greatest intensity, 6 +). The provisional seismological bulletins for July and August 1953 show that the greatest local earthquakes, on July 4 and August 1, both had instrumental magnitude 5·3. The former affected central and western parts of North Island (Tokaanu region), and the latter had an epicentre near lat. 44·8° S., long. 175·8° W.

Museum of Applied Arts and Sciences, Sydney: Report for 1953

THE annual report for 1953 of the Museum of Applied Arts and Sciences, Sydney (pp. 14; published by the Museum, 1954), records the activities of this well-known institution under the energetic directorship of Mr. A. R. Penfold. Although the display side of the Museum is by no means neglected—such exhibits as one demonstrating the energy released by an atomic blast and another of a working compound condensing engine and boiler under steam bear ample witness to this—an impressive amount of scientific work has been accomplished. Such subjects as the establishment of plantations of commercially valuable eucalypts and tea trees in Australia, the effect of modern synthetic fibres on the Australian wool industry, and technical advice concerning paints and varnishes are an indication of the practical use to the nation of the resources of this Museum.

Swedish Physics Conference of September 1952

THE sixth general physics conference of the Swedish National Committee for Physics was held in Stockholm during September 25–27, 1952. As it took place at the same time as the international instruments and measurements conference and exhibition, those attending the physics conference were able to participate in the sessions of the instruments conference, and members of the instruments conference in two of the sessions of the physics conference. The guest lecturers were Prof. E. Bak and Mr. J. R. Anderson, who spoke on microwave spectroscopy and special microwave measurements; Prof. E. Laurila on measuring instruments employing feedback; and Prof. S. Westin on a new electric calculating machine and on geotechnical measurements with strain gauges. The secretary of the physics conference was Dr. Sven Benner, of the Radiophysics Laboratory at the King Gustav V Jubilee Clinic, Gothenburg. Short summaries of the other papers presented to the conference are printed in the January number of *Arkiv för Fysik* (**7**, 73; 1954).

Survey of Field Theory: Physical Society Meeting in Birmingham

THE autumn meeting of the Physical Society will be held in the Poynting Physics Building, University of Birmingham, during December 13–14, the subject being "A Survey of Field Theory". The meeting, which is being organized by Prof. R. E. Peierls, will consist of series of lectures on the interactions between mesons, nucleons, photons and electrons, and, since no specialist knowledge will be assumed, it is hoped that they will be suitable for experimentalists with a general knowledge of quantum mechanics and for theoreticians who do not specialize in field theory. Prof. Peierls will both give an introduction to the proceedings and sum up at the end. The papers will be as follows: fields and particles, by Dr. P. T. Matthews (Birmingham); interactions between fields, by Dr. A. Salam (Cambridge); the state of knowledge of the properties of π-mesons, by Dr. P. T. Matthews (Birmingham); and phenomena involving mesons and nucleons at high energy, by Dr. G. Feldman (Birmingham). Those who are not members of the Physical Society may attend, on completing an application form obtainable from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

University of Leeds

THE following appointments have been made in the University of Leeds: A. Richardson, lecturer in the Department of Electrical Engineering; Dr. J. H. Robertson, Brotherton lecturer in the Department of Inorganic and Structural Chemistry; Dr. P. Feltham and Dr. R. Shuttleworth, lecturers in metallurgy in the Department of Coal Gas and Fuel Industries with Metallurgy and Chemical Engineering; D. Payne, lecturer in agricultural chemistry; and Dr. D. Dowson, lecturer in the Department of Mechanical Engineering. The title of emeritus professor has been conferred on Prof. J. W. Harvey, on his retirement from the chair of philosophy, and on Prof. A. N. Shimmin, on his retirement from the chair of social studies. Recent gifts to the University include the following: £3,900 over three years to the Department of Botany from the Nuffield Foundation for research under the direction of Prof. R. D. Preston on the molecular structure of the cell walls of plants; £1,000 a year for two years to the

Department of Colour Chemistry and Dyeing from the Bradford Dyers' Research Association, this being a renewal of a grant for a research fellowship; a recurrent grant of £800 a year to the Department of Experimental Pathology and Cancer Research from the Medical Research Council for research into the possible carcinogenic fractions from tobacco tar; £3,000 to the Department of Mining from the North-eastern Division of the National Coal Board, this being a renewal of the annual grant, and £3,475 from the National Coal Board for special research projects in the Department; £2,000 to the Department of Psychology from the Department of Scientific and Industrial Research for a research project on the comprehensibility of technical reports; £1,100 a year for two years to the Department of Textile Industries from the Bradford Dyers' Association, Ltd., this being a renewal of a grant for a research fellowship, and £450 a year for seven years from the Dunlop Rubber Co., Ltd., London, for a research scholarship.

Institution of Naval Architects: Scholarships

The Institution of Naval Architects has made the following awards for 1954: Institution of Naval Architects Scholarship in Naval Architecture to J. C. Sainsbury (H.M. Dockyard, Devonport); Vickers-Armstrongs Scholarship in Naval Architecture to A. R. Mountfield (Cammell Laird and Co., Birkenhead); and Yarrow Scholarship in Marine Engineering to G. W. Pinhey (H.M. Dockyard, Devonport). The scholarships are tenable for three years, the Vickers-Armstrongs one being worth £220 a year and the other two £175 a year. In each case the recipient has elected to study at King's College (University of Durham), Newcastle upon Tyne.

Royal Society of Edinburgh

The following have been elected office-bearers and members of council of the Royal Society of Edinburgh: *President*, Prof. James Ritchie; *Vice-Presidents*, Prof. R. C. Garry, Prof. W. M. Smart, Dr. A. H. R. Goldie, Prof. C. M. Yonge, Prof. Norman Feather and Sir Godfrey Thomson; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Dr. T. R. Bolam and Dr. D. M. Steven; *Treasurer*, A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Councillors*, Dr. D. P. Cuthbertson, Principal H. B. Nisbet, Prof. T. C. Phemister, Dr. J. B. Simpson, Prof. Meirion Thomas, Dr. J. M. Cowan, Dr. David Jack, Prof. J. M. Robertson, Prof. D. Whitteridge, Prof. E. M. Wright, Prof. E. L. Hirst and Dr. D. E. Rutherford.

The Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: J. A. Spence (plant pathologist, British Guiana), plant pathologist, Trinidad; A. C. Ellington (senior scientific officer, Government Chemists' Department, Jamaica), assistant government chemist, Government Chemist's Department, Jamaica; J. E. Ho-Yen (senior assistant government analyst, British Guiana), government analyst, British Guiana; R. M. Lawton (assistant conservator of forests, Gold Coast), assistant conservator of forests, Northern Rhodesia; Dr. G. M. Edington and Dr. M. H. Hughes (pathologists, Gold Coast), specialist pathologists, Gold Coast; P. H. Creutzberg and J. C. D. Watts (scientific officers, Sierra Leone), senior scientific officers, Sierra Leone; K. W. Aspinall (veterinary officer, Tanganyika), deputy director of veterinary services, Nyasaland; W. J. Gray (veterinary officer, Nyasaland), veterinary officer, Northern Rhodesia; J. McCulloch (principal veterinary officer, Eastern Region, Nigeria), deputy director of veterinary services, Northern Region, Nigeria; L. E. McLaren (veterinary officer, Jamaica), senior veterinary officer, Jamaica; G. C. Billington (assistant statistician, Gold Coast), senior statistician, Gold Coast; W. L. Booker and J. M. Simmonds (assistant statisticians, Gold Coast), statisticians, Gold Coast; St. G. C. Cooper (agricultural superintendent, Dominica), senior agricultural officer, Trinidad; J. W. Drummond and J. L. Maxwell, agricultural officers, Nyasaland; D. Jack, agricultural officer, Tanganyika; R. J. Jones, D. Juckes and J. Morrison, agricultural officers, Kenya; D. R. Mackay, agricultural officer, Northern Rhodesia; R. L. Morris, agricultural officer, Sierra Leone; J. A. Palmer, agricultural officer, Fiji; R. T. Cannon, R. A. Dujardin and D. G. Price, geologists, British Guiana; C. R. Jones, geologist, Federation of Malaya; D. M. Langbridge, scientific officer, Nigeria; R. H. Ansell, veterinary research officer, Kenya; H. J. Burgess, timber research officer, Federation of Malaya; L. G. Campbell, agricultural engineer, Trinidad; K. Klimacki, geologist, Water Development Department, Tanganyika; D. N. McNutt, entomologist, Kenya; J. R. Sterry, agricultural officer, Gold Coast; B. H. Wyatt, research assistant, Department of Tsetse Control, Gold Coast.

Announcements

We regret to announce the following deaths:

Sir Wallace Akers, C.B.E., F.R.S., lately director of research, Imperial Chemical Industries, Ltd., on November 1, aged sixty-six.

Sir John Lennard-Jones, K.B.E., F.R.S., principal of the University College of North Staffordshire, on November 1, aged sixty.

At the invitation of the Council of the Royal Society of Edinburgh, Prof. James Kendall, the immediate past president of the Society, will deliver the first Alembic Club Lecture of the Society, on January 10, 1955, his subject being "Michael Faraday".

Prof. K. Mothes, of the University of Halle and of the Institute of Plant Culture Research, Gatersleben, of the German Academy of Sciences, has been elected president of the German Leopoldina Academy of Natural Sciences, Halle. Prof. Mothes is a member of the Botany Section of the Academy.

A Tin Research Institute Fellowship has been established at University College, London, and Mr. R. H. Prince has been appointed as the first holder. He will work under the supervision of Prof. E. D. Hughes on certain aspects of the chemistry of organotin compounds.

The Technical Publishing Society, a professional group for the encouragement of the interchange of information among those preparing, editing or publishing technical and scientific documents, has been organized in Los Angeles, with A. E. Tyler, of the United States Naval Ordnance Test Station, Pasadena, as president. Membership includes editors, writers, illustrators, management and production personnel from industrial and government research and development laboratories. Further information can be obtained from the secretary-treasurer, William E. Welch, P.O. Box 607, Tarzana (Los Angeles County), Calif.

ADULT EDUCATION IN GREAT BRITAIN

REPORT OF THE ASHBY COMMITTEE

THE Committee appointed by the Minister of Education in June 1953, under the chairmanship of Dr. Eric Ashby, to consider the organization and finance of adult education in England and Wales, has now presented a unanimous report* which is of wide interest. It includes a concise, coherent account of previous inquiries into adult education and of the regulations which govern its administration. A summary is provided of the written and oral evidence submitted to the Committee, while there are appended, *inter alia*, copies of the resolution sent by the Trades Union Congress to the Prime Minister and Miss Horsbrugh in February 1953 and Sir Winston's reply, in which he stated his belief that "there is, perhaps, no branch of our vast educational system which should more attract within its particular sphere the aid and encouragement of the State than adult education".

It is clear from the report that the Ashby Committee was not asked to examine an organization which had broken down or lost its purpose. It heard no evidence which suggested that the present administrative arrangements are gravely unsatisfactory; indeed, the whole range of evidence, from Sir Winston's letter just quoted to the testimony of those engaged in teaching adult students, was unanimous in the assumption that liberal adult education is still essential. Such changes as the raising of the school-leaving age, the increased provision for secondary education, university expansion and increased assistance given to university students, the development of the cinema, broadcasting and television in a period of full employment have affected adult education, and its content and pattern must change with changing times. No one engaged in adult education, however, is so perturbed by these developments as to question the desirability of the work in which he is engaged, and at the most modest estimate adult education in its present framework serves a purpose which no other agency or activity fulfils.

There are indeed no signs that adult education as an organized activity has, or will become, either universal or lifelong. Out of 31 million adults in England and Wales, only some 150,000 attend adult education classes; but the Ashby Committee believes it to be broadly true that, in relation to the community at large, adult education students represent a social and intellectual asset the loss of which would be deplorable, and it records the hope that the genuine educational desire of such students will never go unfulfilled through lack of funds. This is not to say that the organization and provision of adult education could not be improved, or that its purposes and methods should not be readjusted to meet the needs of contemporary society. Nevertheless, it found no evidence that overlapping is a serious problem in the present system, which is essentially a partnership between the Ministry, universities, voluntary bodies and the local education authorities, with the drawbacks of administrative complexities as well as the mutual advantages which such a system involves. These advantages, however—not merely the enriching of adult education by the partnership of the universities, the voluntary bodies, the local education authorities, and the Ministry, but the enriching of the partners, too—are regarded as so important that, in this period of transition in British education, the Committee recommends they should be preserved. Disclaiming at this juncture any intention to set a course for adult education over the rest of this century, the Committee's advice is essentially to leave well alone.

Some changes indeed are suggested, but the arguments on which the Committee's recommendations are based are perhaps of wider interest than the detailed recommendations. The Committee pays tribute to the labours of the Workers' Educational Association and is unanimous that 'voluntary-ism' as exemplified by the Association is essential to the preservation of the spirit of adult education. Nevertheless, it believes that the future of the Workers' Educational Association will not be secure unless it can resolve its internal conflicts as to the direction and scope of its activity, and translate its decisions into executive action appropriate to its districts.

Of the universities and university colleges, on which has fallen the main burden for providing liberal adult education in England and Wales, the Committee remarks that the high regard which the public has for British universities is due partly to the fact that through their extra-mural departments they have kept close to the people of Britain. It is evident that many universities set a high value on extra-mural work for its own sake, both for this reason and as a duty which scholars owe to their fellow-citizens. There was great diversity of opinion in the evidence from extra-mural departments and the governing bodies of universities, but there was no dispute that universities should continue to take a large share in responsibility for liberal adult education and on no account surrender that responsibility to local education authorities; that full-time extra-mural tutors should be 'assimilated' in salary and status with the rest of the academic staffs; and that student fees should be determined locally and (in general) should not be increased.

While appreciating the traditional prestige and the real value of the longer course, and especially of the three-year tutorial class, the Committee thinks it undesirable from every point of view that university participation in adult education should be restricted to the provision of three-year tutorial and sessional classes. It did not, however, accept the argument that all adult teaching which is done by a university teacher is of 'university standard', and it considered that an extra-mural department which contemplates the provision of a particular course should satisfy itself that the course is one which can properly be given as part of the university contribution to adult education. In the current man-power situation, the caution against the regular employment of university teachers in providing elementary routine courses is timely, and it is coupled with an invitation to the extra-mural departments to consider whether their

* Ministry of Education. The Organisation and Finance of Adult Education in England and Wales. Report of the Committee appointed by the Minister of Education in June 1953. Pp. iv+67. (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net.

resources would not be most usefully employed if, in certain directions, they imposed something of a self-denying ordinance upon themselves.

On all grounds, and in agreement with the great majority of universities, the Committee thinks it would be undesirable for the Ministry to withdraw its direct grants to the universities for adult education, and for the whole financial responsibility to lie with the universities. It sees danger in maintaining extra-mural work indefinitely as a 'protected' activity in universities: adult education, it is observed, will never become an accepted part of university work in the sense that dentistry or psychology is accepted, unless it establishes its right to a share of the university's finances, but it does not consider that this is the occasion to precipitate the fight for recognition. The suggestion of the Association of Education Committees that the University Grants Committee should make itself responsible for financing all extra-mural work done by universities and that local education authorities should be responsible for financing the provision of all the rest is rejected, because of the weakening effect the proposal might have on voluntary effort and the risk of uneven interpretation. The Committee recommends that the Ministry should not only continue to give direct grants to the bodies responsible for adult education but also should be prepared to exercise on occasion a more active and flexible control of expenditure.

The Committee stresses the importance of this flexibility, which it would not merely preserve but even increase. The present diversity of pattern in the provision of adult education is regarded as an advantage: there is no evidence that it causes appreciable overlapping or extravagance in expenditure; and a uniform pattern, though it might appear efficient on paper, would suffer from all the inefficiencies of a system which takes no account of local differences. Accordingly, the Committee recommends that the present method of fixing grant ceilings on the basis of grant carried in the year when expansion was checked should be discarded. In its place a system should be adopted under which allocations representing the maximum amount of grant available to each responsible body for the coming year should be made after consideration of the quality and standards of work being done by that body, as well as its proposed programme, the needs of the region in which it operates, and the activities of other interested bodies in the region. The limits on the salaries of full-time tutors recognized for grant should be removed, although responsible bodies should still be required to obtain the Ministry's approval for new full-time appointments on which grant would be sought. It would also raise the level up to which fees of part-time tutors are recognized for grant, and in the calculation of grant the conception of sessional rates of payment for part-time tutors of tutorial classes should be replaced by rates of payment by the hour or by the meeting.

The Committee also recommends the amendment of Further Education Grant Regulations so as to give less prominence to the length of course as compared with other criteria. Classes for special groups of students should be acceptable for grant provided the enrolment of other students is not unreasonably prohibited and the Committee would not exclude courses of high quality from grant on the grounds of vocational interest. It recommends that responsible bodies should be given some assurance that the total allocation of grant for adult education should not be reduced at short notice. It would widen the interpretation of teaching costs to include, besides the primary responsibility of teaching costs, such work as responsibility for a library service or giving guidance to junior colleagues. Local conditions should be the primary consideration in fixing student fees. Such fees should be kept under review and raised if local conditions justified and necessitated this action; and both the Minister and local education authorities in determining their grants should take into account the total financial contribution being made by the students.

As regards the content of courses, the Ashby Committee thinks that money is well spent in satisfying a genuine demand from students who are prepared to throw themselves whole-heartedly into the work of the class; but that public money should not be spent on titillating the interest of students who are not prepared to make some sacrifice of their own time and effort to work at the subject of the class. As regards the content of the subject taught, the Committee would be sorry to see a list of approved subjects drawn up, because it would soon become obsolete and its very existence would discourage fresh ideas. This is a main reason for the suggestion that the Minister should establish a small committee to advise from time to time on the subjects and types of adult education courses which should receive priority in qualifying for grant.

The Ashby Committee's report, for all the merit of the minor improvements it recommends, is probably of most value as a stimulus to the constructive thinking which not only such a Committee but also the responsible bodies, local authorities and others should be giving to the scope, the functions and content of adult education in our changing social pattern.

THE PHYSICS OF THE IONOSPHERE

THE Physical Society held a Conference at the Cavendish Laboratory, Cambridge, during September 6–9, on "The Physics of the Ionosphere". It was attended by about 150 delegates, many of them from overseas. The subjects discussed were: the lowest ionosphere; irregularities and horizontal movements in the ionosphere; the $F2$-layer; the mathematics of wave-propagation through the ionosphere. Under each of these headings a paper was read which summarized the existing background of knowledge against which the discussion could take place. In the discussion itself short prepared contributions, which had previously been circulated in print, were first presented, and were followed by a general discussion on special problems. Most of the contributions to the prepared discussion will be published as full-length papers in a report on the Conference (available from the Secretary-Editor, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7). Some of the more interesting points emerging from the Conference are mentioned below.

D. F. Martyn presented the latest stage of his work on movements in the F-layer. He first pointed out that, when Hall effects are taken into account, in a modification of Schuster's theory of the atmospheric dynamo, the electrostatic polarization in the

dynamo region is different from that deduced originally by Schuster. The fields produced, in the *F*-layer, by this polarization in the dynamo region would explain the major vertical and horizontal movements of that layer. Finer detail can be explained in terms of diffusion if the air density in the *F*-region is as small as seems to be indicated by recent rocket measurements. This latest stage of Martyn's work seems to bring us near the proper explanation of most problems of movement in the *F*-layer.

Delegates to the Conference were fortunate in hearing the first account of some of the scientific results which have resulted from a study of the forward scattering of 50 Mc./s. waves from the ionosphere. D. K. Bailey surveyed evidence which suggests that this scattering occurs at heights between 75 and 90 km. The height and the intensity of the scattering vary with season and with time of day. Preliminary results concerning the resultant distribution of signal amplitude over the ground were presented, both in terms of the speed of fading and of the auto-correlation function in distance. It is certain that these results, accumulated in the United States over a period of several years, will be of great importance for ionospheric theory; it is too early yet to try to assess their significance in detail.

The workers at the Naval Research Laboratory, Washington, led by E. O. Hulburt, one of the earliest ionospheric physicists, presented some most interesting and stimulating suggestions about the formation of the ionized layers. Measurements made recently with rockets were quoted to support the suggestion that both the *E*- and the *F*-layers are produced by X-rays and that, although the *D*-region is mainly ionized by ultra-violet light (Lyman α), the extra ionization at times of sudden ionospheric disturbances is produced by X-rays.

The absorption of waves of frequency between 2 and 4 Mc./s. was discussed, and the widespread belief that it could mostly be accounted for by *D*-region absorption, obeying the frequency law appropriate to a non-deviating region, was questioned. The majority of the workers on this subject were represented at the Conference and they had some fruitful discussion, without reaching any agreement. It was, at any rate, realized that the matter is still open to question.

Observations of echoes returned at vertical incidence from heights between 80 and 100 km. on frequencies near 1 Mc./s. were described. There was disagreement about whether the echoes represent total reflexion from an over-dense layer, partial reflexion from a sharp gradient of electron density, or scattering from irregularities.

Several new results were reported concerning irregularities and horizontal movements in the ionosphere. S. A. Bowhill suggested that in the lowest part of the ionosphere the irregularities of electron density have two sizes, a larger one low down and a smaller one higher up, and that the way in which the fading speed varies when the radio-frequency is changed from 16 to 2,400 kc./s. can be explained in terms of them. He also suggested that the mean drift-velocity of the larger irregularities is smaller than their random velocities, whereas the opposite is true for the smaller irregularities.

A consideration of the amplitude of successive echoes reflected from the *E*-layer on a frequency of 150 kc./s. led R. L. Schrag to suggest that, at night, the layer sometimes acts like a concave mirror and produces a focusing of the waves returned to the earth. This appears to be the first time that focusing has been noticed from the *E*-layer, although it is a well-known phenomenon with *F*-layer echoes.

J. L. Pawsey mentioned that workers at the Radio Physics Laboratory in Sydney had noticed ionospheric focusing of the radiation from radio stars received at shallow angles. It was not certain whether the focusing was produced in the *E*- or the *F*-layer. Evidence was presented to show that, on the average, the shape of the ionospheric 'lenses' is not circular.

It was emphasized that all radio methods measure the movements of irregularities of electron density, and that these are not necessarily the same as the movements of the air or even of the surrounding electrons. It is therefore important that the subject should not be confused by describing these movements as 'winds'; they could more precisely be called 'drifts'. In this connexion, P. C. Clemmow, K. Weekes and M. A. Johnson presented a paper which showed that a cylinder of enhanced ionization, immersed in a background of ionization, in the presence of a magnetic field would move in a direction which depended on the collision frequency of the electrons and might be different from the direction of motion of the surrounding ions.

Several speakers dealt with the question of the distortion of the *F*-layer at times of ionosphere disturbance. Sir Edward Appleton and W. R. Piggott suggested that the effects of disturbances depend on the epoch in the sunspot cycle, and that there is a difference between the rising and the falling parts of the cycle. S. Matsushita, and R. W. Wright and N. J. Skinner discussed the effects of disturbances in the equatorial zone.

It was frequently mentioned that, although a very great effort is put into obtaining ionospheric $h'(f)$ records from all over the world, the amount of information available from them, for purposes of ionospheric physics, is not as great as it might be. Several speakers discussed how the height distribution of electrons could be deduced from the records. The main emphasis was on the shortening of the computations and the inclusion of the effect of the earth's magnetic field. It appeared that the required computations could be carried out, with comparatively little labour, so as to indicate the state of the ionosphere at one place on an average magnetically quiet day in any month, and the hope was expressed that an organization might be set up to perform computations of this kind for the observations from a few selected sites during the forthcoming Geophysical Year.

In the part of the Conference dealing with mathematics, the discussion centred, as was intended, on mathematical methods rather than on the results obtained. A series of papers dealt with the problem of tracing rays through the ionosphere in the presence of the earth's magnetic field. This problem was solved, in principle, several years ago. The new work is concerned with methods which are sufficiently rapid for practical application, and some of them seem to be promising in this respect. If these can be brought into routine use, there will be considerable improvement in the calculations of maximum usable frequencies.

Other mathematical papers dealt with the coupling of the characteristic waves in the ionosphere, and with the detailed statistics of the collisions of electrons with heavy particles and its bearing on magneto-ionic theory.

The Physical Society is to be congratulated on arranging such a successful conference at a time when a large proportion of those actually engaged in ionospheric research could be present. The publication of the report, which is promised soon, will add considerably to the value of the Conference.

CARBON-14 DATING

SYMPOSIUM IN COPENHAGEN, SEPTEMBER 1–4

IT is now generally recognized that the method of dating organic material by assay of radiocarbon content is of outstanding promise for many sciences, particularly archæology and the aggregate of archæology, geology and biological sciences which can be called 'Quaternary research'. The demonstration of its feasibility by W. F. Libby was followed by the initiation of many projects for radiocarbon dating, centred in North America and in Europe. Those most concerned in North America have already had more than one joint meeting, but European workers have remained relatively isolated from one another until this year, when they attended an informal symposium in Copenhagen.

The meeting was sponsored by the Danish Rask–Ørsted Foundation, and was actively supported by the organizing committee of the Copenhagen carbon-14 project which has been operating since 1951 under the chairmanship of Dr. Therkel Mathiassen. The secretary of the meeting was Dr. Hilde Levi, head of the Copenhagen carbon-14 dating laboratory, and, through her, invitations were sent to the several European centres known to have carbon-dating plant working or under construction: two or three members attended from each centre.

The first day's discussion opened with consideration of technical matters associated with solid-carbon counting by methods essentially those of W. F. Libby, as now being used in Copenhagen and in Rome, and in preparation at Trondheim and Stockholm. This was followed by accounts of the processes being worked out for the use of gas-counters with the carbon in the form of carbon dioxide (Groningen and Heidelberg), acetylene (Royal Institution, British Museum and Harwell jointly, and Cambridge), and methane (Göteborg). Many interesting aspects of the production of the counting gases were considered, more particularly the hydrocarbons.

It became perfectly clear that gas-counting both by carbon dioxide and by acetylene is more expeditious and somewhat more sensitive than screen-wall counting of elemental carbon, and may be expected to displace the older method, which nevertheless is now producing a large part of the published datings. Only brief reference was made to scintillation counting.

Discussion on the third day concerned sources of error inherent in the samples and the techniques, and precautions which they involve, and some brief consideration of datings secured by European projects. It was apparent that, while cross-checking of samples could usefully be considered in this way, the implications of several unpublished datings were far too wide for the limited personnel and time of the meeting.

Some consideration was given to the standardization of form of publishing results, and to dating projects requiring international organization. It was agreed that a second symposium ought to be held, at least to deal with technical advances, within the next year or so and that *rapprochement* should be sought with American colleagues.

This first meeting proved extraordinarily profitable to all participants, not least because of the close personal discussions made possible by its small size and informal nature. The hospitality of our many Danish hosts and the skill and tact of Dr. Levi in organizing the meeting were beyond praise.

H. Godwin

HYDERABAD CENTRAL LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1952

THE annual report for 1952 of the Central Laboratories for Scientific and Industrial Research, Hyderabad*, which has only recently been published, refers to the slow progress of the new building, towards the completion of which the Government of India sanctioned a non-recurring grant of 5 lakhs of rupees. Research in the Oils and Entomology Sections during the year included the preparation of insecticidal material from sitaphal seed and soap-making trials of sitaphal oil, the dehydration of castor oil, continuous preparation of triricinolein, indigenous cotton-seeds and their oils, separation of fatty mixtures and the antioxidant properties of aca-catechin. The Fibre and Paper Section examined the possibilities of manufacturing filter and board paper from tailor wastes and of using casuarina wood pulp as a diluent for cotton-seed linters. The Fuel Section made a rapid survey of the distribution, classification and available reserves of Hyderabad coals and continued its systematic physical and chemical survey. A pilot-plant investigation of the briquetting of non-caking coals has been undertaken and, in connexion with the installation of the Lurgi low-temperature carbonization plant, the weathering properties of Hyderabad coal and its oxidation in a fluidized bed, the recovery of tar acids and hydrocarbons from low-temperature tar and of benzole from carbonization gas are being studied.

The Heavy Chemicals and Fertilizers Section has been concerned with the utilization of felspar and iron pyrites, and of sulphates for the manufacture of sulphuric acid as well as the preparation of activated charcoal from groundnut hulls. A systematic study of Hyderabad clays was made in the Ceramic Section as well as a study of their utilization as fireclay refractories. The work of the Organic Chemistry, Pharmaceutical and Drugs Section included studies of potential synthetic analgesics, including quinazoline derivatives and a new synthesis of pethidine, studies on Indian turpentine and alkaloids and attempts to synthesize compounds with sex hormone activity. In the Biochemistry Section, fermentation studies included the production of citric acid from sugar-cane molasses and of itaconic acid from glucose, using *Aspergillus terreus*; non-fermentation studies included the production of lævulinic acid from sugar-cane bagasse.

* Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1952. Pp. xi+57. (Hyderabad-Deccan: Osmania University Press, 1954.)

X-ray studies were made on Hyderabad clays and on stilbene derivatives, and the conductivity of lithium nitrate in mixtures of methyl and ethyl alcohol and the isomerization of chromic chloride hexahydrate were studied in the Physical Chemistry Section. The Analytical Section is working out a method for the determination of tartaric acid with potassium dichromate, and a systematic study of the fusel oil from the Nizam sugar factory, Bodham, Hyderabad State, indicated that it contains 50 per cent of amyl alcohol with fair proportions of propyl and *iso*propyl alcohol. Besides erecting the low-temperature carbonization plant, the Chemical Engineering Section determined the solubilities of groundnut oil in 98 per cent ethyl alcohol at 40–60° C., while the Operational Research Unit was concerned with the manufacture of fructose on a semi-commercial scale, of triricinolein and of sesamin.

OXFORD SYSTEM OF DECIMAL CLASSIFICATION FOR FORESTRY

FOREST bibliography has for long been a difficult subject to deal with, more especially since forestry research institutes and new forest departments and their resulting publications began to make their appearance. Certainly nowadays it would be almost impossible to keep *au fait* with the great output of forestry literature without some form of international classification.

The International Association of Forest Research Institutes—since 1929 called the International Union of Forest Research Organizations—had put the question of forest bibliography on its programme as early as 1903 with the object of creating a minimal system of classification and an international forest bibliography, the work being then entrusted to a Bibliographical Committee. The subject was discussed at the three international forestry congresses held in Rome (1926), Budapest and Helsinki. From the outset, the Swiss forester, Dr. Philipp Flury, was one of the most ardent workers in this new cause in preparation, and it was not until 1933 that the Committee presented to the International Union a complete system of classification of forest literature which was adopted in congress. It bore the title "Forest Bibliography", but became widely known as the "Flury System". It was assigned the decimal signature 634·9 F, to distinguish it from the heading 634·9 forestry in the Universal Decimal Classification, which differs in the details of its sub-division. One of the Flury System's main uses was to classify the title references comprising the International Forest Bibliography—a scheme organized by the International Union for the regular exchange between member countries of references to literature considered to be of international importance.

The first post-war meeting of the Bibliographical Committee was held in Zurich in 1948 under the chairmanship of Prof. H. Burger. At this meeting Mr. F. C. Ford Robertson, director of the Commonwealth Forestry Bureau at Oxford, presented a completely revised system of classification for forest literature which had been prepared by his Bureau in consultation with the chief research station (Alice Holt) of the British Forestry Commission and the Forest Products Research Laboratory at Princes Risborough. This revision was based upon ten years of experience gained by the Bureau in the course of its day-to-day work in abstracting and classifying the world flow of forestry literature.

When a working agreement had been reached between the International Union of Forest Research Organizations and the United Nations Food and Agriculture Organization, the International Council of the former proposed to the latter the appointment of a joint Bibliographical Committee to study the new classification and to make appropriate recommendations to both. This was to supersede the previous Committee, and on it was appointed A. Oudin, director of the Nancy Forestry School, F. C. Ford Robertson and E. Saari, professor of economics in the University of Helsinki. J. D. B. Harrison and R. G. Fontaine were appointed by the Food and Agriculture Organization. Meetings of the Committee were held at Helsinki, Oxford, The Hague, Wageningen, Oxford and Rome. During this period the new classification system submitted by the Commonwealth Forestry Bureau at Oxford was carefully examined, and at various stages of revision was widely circulated to members of the International Union and research stations throughout the forestry world. Throughout the four years of revision, the Commonwealth Forestry Bureau acted as the natural clearing house for the work of correspondence and collation involved, in which Mr. P. G. Beak, assistant director of the Bureau, proved an invaluable helper.

The definitive English text of the new system of classification (which runs to 115 pages) is called the "Oxford System of Decimal Classification for Forestry"* and was finally presented to the International Congress in Rome in September 1953, when it was unanimously adopted with the recommendation that translations of the English text should be published in French, German and Spanish. The Food and Agriculture Organization, at its seventh session in Rome, approved of the system with a few resolutions on the subject of periodical revisions and so forth.

E. P. STEBBING

* The Oxford System of Decimal Classification for Forestry. (Being the Definitive English Version as authorized by the Rome Congress of the International Union of Forest Research Organizations, September 1953, and published on their Behalf by the Commonwealth Agricultural Bureaux.) Pp. 115. (Farnham Royal: Commonwealth Agricultural Bureaux, 1954.) 10s.

SUBMARINE ILLUMINATION AND THE TWILIGHT MOVEMENTS OF A SONIC SCATTERING LAYER

By ELIZABETH M. KAMPA and BRIAN P. BODEN

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IT has long been recognized that many zooplankton organisms exist in distinct strata during the day and that they may undergo extensive diurnal vertical migrations. The similarity of their behaviour to that of certain sonic-scattering layers in the sea, observable with echo-sounding equipment, led Johnson[1] to suggest that the origin of these layers is biological. Collections by various methods have shown that concentrations of both zooplankton and fishes are associated with these layers. Although much thought has been devoted to the composition of the layers and to the acoustic properties of the animals probably comprising them, attention to the causes of

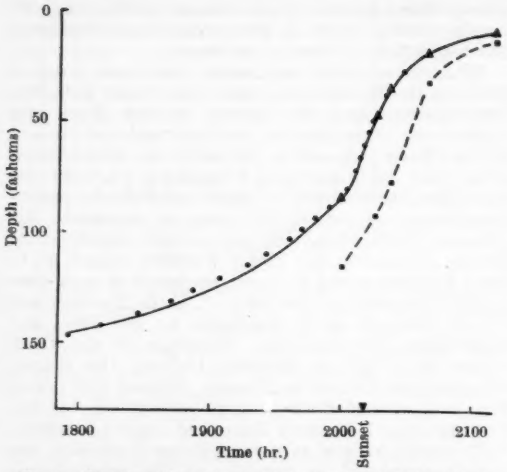

Fig. 1. Evening ascent of a scattering layer and of the $6{\cdot}6 \times 10^{-4}$ foot-candle isolume. Solid line represents top of layer as seen on *NMC*-1 fathometer record, round dots represent measured positions of the isolume, triangles represent scattering at 9·6–20 kc./s.; solid squares (– – –) represent scattering at 2·4–3·4 kc./s.

their vertical migrations has been restricted to speculation and to laboratory experiments with individuals.

As a first step in determining these causes, the change of depth of a certain level of submarine illumination during twilight is compared here with the depths of a certain scattering layer during its vertical migration.

Intensity of illumination at depth was measured with a submarine photometer designed expressly for this purpose by James M. Snodgrass, of the Special Developments Division at the Scripps Institution of Oceanography. This instrument, described previously by Kampa and Boden[2], employs an *RCA* 931*A* photomultiplier tube which is sensitive to wavelengths between 300 and 700 mμ. The sensitivity has a sharp peak at 400 mμ and drops to 50 per cent at 320 mμ and 518 mμ. The tube is protected against pressure at depth by an oil-filled glass riding-light cover which makes water-tight contact with the brass cylinder containing the submerged portion of the photometer circuit.

The photometer was calibrated with a Weston illumination meter using a 100-watt *G.E.* projection bulb at 115 volts.

During the observations reported here, the submerged unit was rigged in such a way that the sensitive surface of the photomultiplier tube was vertical, favouring measurement of horizontal illumination.

When a curve of equal illumination was to be determined for comparison with scattering layer position during vertical migration, the submerged unit was lowered to the depth of the top of the layer, and the light intensity and time were recorded. This time was noted on the fathogram as well. The photometer was then either raised (sunset) or lowered (sunrise) 10 m. and held at the new position until meter readings showed that the illumination intensity was the same as that previously observed. The time was again recorded. This process was repeated until the fathogram showed that the scattering layer position had become relatively constant, either at the surface or at depth.

Scattering layers were observed with an *NMC*-1 fathometer operating at 17·5 kc./s. A more detailed analysis of the scattering properties of these layers was effected by a multiple-frequency technique similar to that employed by Hersey, Johnson and Davis[3]. The wide-band sound source in this analysis was a half-pound block of TNT detonated at the surface about 30 m. from the receiver. The receiver was a directional Rochelle salt hydrophone directed vertically downward just below the surface at the side of the ship. Sounds received by hydrophone were recorded with a 'Magnecord' 63*AH* tape-winder with *PT*7-*P* 'Magnecord' amplifier adapted to operate at 30 in. per sec. The record of echoes from each explosion was filtered through an H. H. Scott Type 420-*A* sound analyser, and an oscillographic record was made of the reverberation at various frequencies using a triggered single-sweep oscillograph fitted with a 'Polaroid' Land camera.

Biological collections were made from each layer under observation with a 1-m. plankton net of 8 ××× bolting silk. This net could be opened and closed at depth by means of the Leavitt[4] opening and closing device. A time–depth recorder was incorporated in the collecting gear to give a record of the fishing depth of the net. After superficial examination these collections were dark-adapted in running sea water and then deep-frozen. A report of the light-sensitive substances obtained from these animals will be presented shortly.

Fig. 1 shows the twilight ascent of a scattering layer in the San Diego Trough on June 30, as well as the ascent of the level of illumination ($6{\cdot}6 \times 10^{-4}$ foot-candles) with which this scattering layer had been associated during the afternoon. It can be seen that the ascending scattering lags behind the ascending light intensity between 1830 and 1950 hours (P.D.T.).

This layer was observed to split into two components during its migration. A similar splitting of the single layer during ascent was observed on the following evening when the multiple-frequency technique was employed (risk of damage to the light meter precluded its use while TNT was being detonated). Fig. 1 also shows the ascent of this split layer on July 1. The upper component of the split layer scattered relatively high frequencies (9·6–20 kc./s.), whereas the lower component scattered only lower frequencies (2·4–3·4 kc./s.). Fig. 2 shows oscillo-

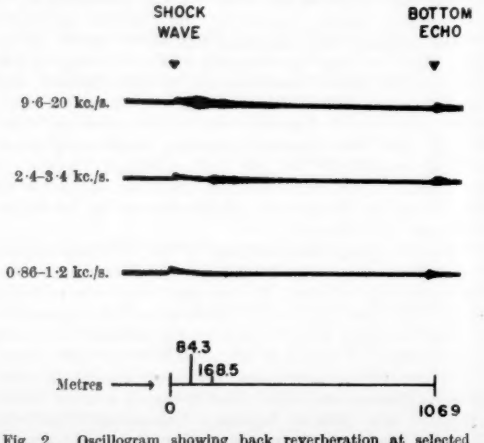

Fig. 2. Oscillogram showing back reverberation at selected frequency pass-bands. Peaks of scattering can be seen at 84·3 and 168·5 m.

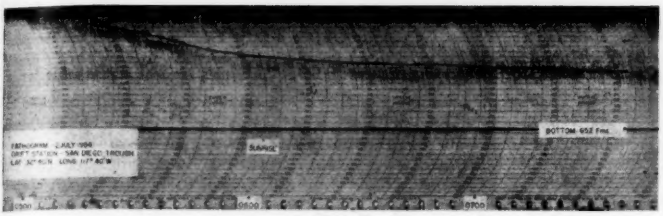

Fig. 3. Fathogram of layer descending in the morning. The $5{\cdot}9 \times 10^{-5}$ foot-candle isolume is superimposed

grams of reverberations from the second TNT explosion in the July 1 (Fig. 1) series. The upper component, scattering at higher frequencies, is apparent at 84·3 m. (46·1 fathoms), while the lower component is at 168·5 m. (92·4 fathoms).

Fig. 3 is a fathogram made in the San Diego Trough on July 2 during morning twilight to sunrise. As soon as a scattering layer could be observed breaking away from surface scattering, the photometer was lowered to the top of the layer. The intensity of illumination here was $5{\cdot}9 \times 10^{-5}$ foot-candles. The descent of the $5{\cdot}9 \times 10^{-5}$ foot-candle isolume is superimposed on the fathogram. It can be seen that the descending layer and the isolume enter and continue through a layer which had persisted through the night at about 135 fathoms.

The extremely close correlation between the vertical movements of a scattering layer and those of a constant level of illumination (Figs. 1 and 3) argues strongly that the migrations of these layers are simple responses to variations in environmental light intensity. The slight lag in the ascent of the layer behind that of the isolume (Fig. 1) during the early part of the migration suggests that, although 0·00066 foot-candles may constitute an optimum illumination for the scatterers, the threshold intensity for migration is slightly lower. This threshold was reached apparently at about 1900 hours, and the scatterers increased their rate of ascent. Shortly before sunset the layer overtook the isolume, and, at sunset when the ascent is most rapid (about 2·75 fathoms per minute), the rates of ascent of illumination-level and scattering layer are identical.

It is interesting to note that the illumination intensity ($5{\cdot}9 \times 10^{-5}$ foot-candles) with which the descending layer (Fig. 3) was associated on July 2 is less than one-tenth of that determined for the ascending layer on June 30 ($6{\cdot}6 \times 10^{-4}$ foot-candles). Assuming that these layers were similar in biological composition—an assumption which was borne out by collections taken from them—it seems that during the moonless night the animals became dark-adapted and consequently more sensitive to lower light intensities. The extent to which various degrees of dark- and light-adaptation influence the position of the scatterers relative to illumination-level demands further investigation.

Frequency analysis, at the time the fathometer has revealed the splitting of a layer during ascent, shows that the upper component, which seems to be responding to a photic stimulus, scatters sound at 9·6–20 kc./s., whereas the scattering peak of the lower component is at 2·4–3·4 kc./s. This is evidence that the upper part of the layer may be comprised of smaller organisms (invertebrates ?) and the lower part of larger ones (fish ?).

Thus we have the picture of a heterogeneous layer existing during the day at an illumination intensity which is optimum for one or more animals associated with the layer. During the evening twilight this organism ascends with its optimum intensity and is followed by predators which have been in the layer during the day. This contention is supported by the results of Tucker[5], whose analysis of net hauls taken in the layer led him to conclude that invertebrates (euphausiid crustaceans) were the dominant organisms in the upper part of the layer, while fish were dominant in the lower part of the same layer. Rigidly controlled biological collections from different components of the layer during vertical migration promise to do much in elucidating which organisms are responding to light and which are merely following a migrating food source.

This work is being conducted under contract between the Geophysics Branch of the Office of Naval Research and the Scripps Institution of Oceanography, University of California. [Aug. 7.

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THE INTERTIDAL FLORA AND FAUNA OF THE CHATHAM ISLANDS

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IN January–February 1954 an oceanographic expedition from Canterbury University College and Canterbury Museum, sponsored by the New Zealand Oceanographic Committee, visited the Chatham Islands in the M.V. *Alert*. This group of islands and rocks lies 560 miles due east of Banks Peninsula on the South Island, New Zealand, the largest member of the group, Chatham Island, being about thirty miles long. During the time spent round the Islands opportunity was taken to make observations on, and fairly complete collections of, intertidal plants and animals, at several localities on the main island and on many of the outlying islands.

The Chatham Islands lie in a zone of mixed cool sub-antarctic and warm sub-tropical water. Cool sub-antarctic water passes up the east coast of the South Island and is deflected east towards the Chatham Islands when it impinges on a tongue of warm sub-tropical water from the north, described by Fleming[1] as the East Cape Current. The area of intermingling, known as the Sub-tropical Convergence[2], is clearly defined at times, ill-defined at others, and varies considerably in position seasonally and from year to year[3]. The Chatham Islands, then, are subject to both sub-tropical and sub-antarctic influences in varying degrees, and this has an important bearing on the flora and fauna of the intertidal region.

A striking feature of the intertidal ecology of the Chatham Islands to one familiar with the New Zealand shores is the odd mixture of species characteristic of the northern and southern parts of New Zealand; for example, algae such as *Apophloea lyalii* Hook. f. et Harv. and *Pachymenia lusoria* (Hook. f. et Harv.) J. Ag., found only in the southern part of the South Island and Stewart Island, grow alongside other species, such as *Carpophyllum plumosum* (A. Rich.) J. Ag., which are limited to the northern part of the North Island. Moore[4] states that, of the 190 species of algae recorded from the Chatham Islands, ten are not otherwise recorded from New Zealand and the rest are a mixture of northern and southern species. Powell[5] has recorded 256 species of intertidal and shallow water molluscs from the Chatham Islands. Of these, forty-seven are endemic species or subspecies, and he states that there is an approximate equality in numbers of species that definitely show either northern or southern origin.

Many characteristics of the intertidal zonation, such as the absence of serpulid and *Mytilus planulatus* zones and the presence of a well-marked *Apophloea lyalii* zone, are those found only in the extreme south of the South Island and Stewart Island. Others, such as the development of *Chamaesipho brunnea* and Vermetid zones, are characteristic of the zonation of northern New Zealand shores. The basic pattern of zonation, with a well-developed *Durvillea* zone, is that of the southern, cold-temperate, New Zealand shores with some northern, warm-temperate, New Zealand features superimposed, as well as a number of endemic features.

Another striking feature is the complete absence of many of the commoner species of the New Zealand shores. Notable examples are the barnacles, *Chamaesipho columna* Spengler, *Elminius modestus* Darwin and *Pollicipes spinuosus* Quoy and Gaimard, the common intertidal serpulid, *Pomatoceros coeruleus* (Schmarda), and the molluscs, *Amaurochiton glaucus* (Gray), *Mytilus canaliculus* Martyn, *Modiolus neozelanicus* (Iredale), *Nerita melanotragus* (Smith), *Lunella smargada* (Martyn), *Scutus breviculus* (Blainville) and *Benhamina obliquata* (Sowerby). Other species, such as *Mytilus planulatus* Lamarck, were present only in very limited numbers and were not band-forming species as on the New Zealand coasts. Only one species of limpet, the endemic *Cellana chathamensis* (Pilsbry), occurs intertidally, whereas at least two or three species of *Cellana*, as well as several patelloid limpets, are to be found in most parts of New Zealand. Graspoid crabs were absent, as well as the anomuran, *Petrolithses elongatus* Milne-Edwards. On the New Zealand shores the latter species is one of the commonest and most ubiquitous animals. The complete absence of crabs above mean low-water neaps is an unusual feature not found on other southern temperate shores. Absences were not so marked among the algae, the majority of the dominant intertidal species of the New Zealand coasts being present. One example is *Durvillea willana* Lindauer, although *Durvillea antarctica* (Champ.) Hariot is abundant and another species *Durvillea caespestipes* (Mont.) Skotts[6] occupies a similar place on some Chatham shores to that of *D. willana* on the New Zealand shores.

The absence of certain species has led to some interesting changes in the vertical zonation of others when compared with their zonation on the New Zealand shores, and serves to illustrate the effect of competition in determining the limits of intertidal plants and animals. Extremely interesting and difficult to account for is the absence of the commonest New Zealand intertidal barnacle, *Chamaesipho columna*, as this species occurs throughout New Zealand, the Kermadec Islands and temperate Australia. On the New Zealand shores *Chamaesipho brunnea* occupies a comparatively narrow zone from about mean high-water neaps to mean high-water springs, above the optimum development of *C. columna* which extends down to about mean low-water neaps. On the Chathams, with the absence of *C. columna*, *C. brunnea* extends throughout the midlittoral zone down to the upper limit of the brown algal zone at mean low-water neaps. Apart from competition between adult barnacles, the difference in the breeding season of the two species of *Chamaesipho* is probably an important factor in determining their relative ranges in New Zealand. *C. columna* breeds throughout the year, whereas *C. brunnea* has a more restricted breeding season from September to February[7].

A consideration of the above evidence leads to the conclusion that the Chatham Islands intertidal region has been populated from New Zealand. This conclusion is supported by geological evidence. Finlay[8] states that the whole of the recent molluscan fauna of the Chathams seems to be independent of the Tertiary faunas, the most characteristic shells inhabiting the shores not being represented in Pliocene beds[9]. He concluded that "the Recent Molluscan fauna of the Chatham Islands is not a remnant or an evolution of the Tertiary fauna found there, but a repopulation from the mainland, in Post-Pliocene times, but yet long enough ago for characteristic regional species and sub-species to have evolved". Few endemic intertidal species have been recorded in the other animal groups and in the algae. More may, however, be recorded when the results of the present expedition have been worked out; but, apart from mollusca, nearly all the dominant intertidal plants and animals are also found on the New Zealand shores.

The absences pose some interesting problems concerning the means of dispersal of the species involved. Establishment of an intertidal population across a sea barrier can take place by the transport of sufficient numbers of larval stages by current systems, or adults by floating objects or by shipping. Drifting kelp was observed throughout the voyage to and from the islands, and it probably formed an important method of dispersal in the past. Some mainland animal species which are closely associated with brown algae, such as the anemone *Cricophorus nutrix* (Stuckey) which is practically confined to species of *Cystophora*, are also found at the Chathams; others are absent. Although *Durvillea antarctica* is abundant at the Chatham Islands, the chiton *Frembleya egregaria* H. Adams, one of the dominant species confined to *Durvillea* holdfasts on the New Zealand shores, has not been recorded. Another dominant species, *Siphonaria australis*, is rare, and was first recorded by the expedition. A second chiton, *Ornithochiton neglectus* Rocheburne, occurs abundantly in holdfasts both in New Zealand and the Chathams. Shipping may have formed a transporting agent in recent times, but it is interesting that no specimens of the barnacle, *Elminius modestus*, were found, although it has recently been introduced to Europe[10].

Crisp and Southward[11] have recently discussed the influence of sea barriers on the distribution and evolution of predominantly intertidal plants and animals and conclude that "a critical distance must

exist, related to the current system and the duration of the free swimming stages, beyond which the rate of settlement of the larvæ is normally insufficient to reach the minimal population density within the lifetime of an individual". As yet there is very little information available regarding the life-histories of New Zealand intertidal animals. Information is, however, available concerning the current velocities between New Zealand and the Chathams. Young[12] reports that light wreckage from Cook Strait has been picked up three weeks later on the north side of Chatham Island. Drift bottles liberated off the Otago Heads have been picked up on various parts of the island from 3 to 15 months later[13]. The velocities of these currents would be sufficient to transport the free-swimming larvæ of many species.

Detailed results of this investigation of the intertidal ecology of the Chatham Islands will be published elsewhere. The expedition which enabled the above observations to be made was financed by a grant from the New Zealand Council of Scientific and Industrial Research, with contributions from Canterbury University College, Canterbury Museum, the Dominion Museum and the Canterbury Branch of the Royal Society of New Zealand. This assistance is gratefully acknowledged. I also wish to thank Dr. M. Naylor and Mr. R. K. Dell for helpful discussion.

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EXPERIMENTAL CHEMICAL CARCINOGENESIS AND THE INFLUENCE OF SOLVENTS

RESEARCH IN FINLAND

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STUDYING the mechanism of experimental tumorigenesis there are—besides the cancer-provoking agent itself—several factors influencing essentially the development of tumours. The majority of these factors are, however, still totally unknown. Even the few which can be regarded as known need further explanation. It may therefore be of value to summarize some of our present knowledge and try to illustrate the significance of some of the observations already obtained.

Cancer-provoking agents as used in experimental research are, in general, the fat-soluble aromatic polycyclic hydrocarbon carcinogens. When they are employed for an investigation on living biological material, it is necessary to bring these fat-soluble substances into close contact with the aqueous environment of the organism. In applying fats and/or fat-solvents as vehicles for the carcinogen, a number of factors, not easily controllable, are introduced which modify the results. A considerable number of investigations dealing with factors which alter the action of tumorigenic agents confirm the existence of some kind of 'solvent effect'. The nature of this is unknown. That is why the effect of the vehicle used and that of the actual carcinogenic agent cannot be clearly distinguished from each other. It seems possible, however, that a satisfactory explanation of this particular circumstance would throw additional light to the question how the carcinogenic hydrocarbons actually function.

Selecting suitable mediators for the carcinogen, it is logical to examine the physiology and pathology of living matter for suggestions as to their required nature[1-3]. One should take into account the large body of data which has been accumulated, for example, upon the chemistry and fine structure of protoplasm and its derivatives, intercellular substances and the permeability phenomena. (On these matters I consulted (at the beginning of 1946) Prof. R. Collander (Institute for Botany, University of Helsinki), a leading investigator on the permeability of cells, who agreed with this view, and made some illuminating comments.) The vehicles in the present experimental series ought to satisfy, so far as possible, the following demands: (1) in principle they should be as 'physiological' as possible; (2) they must be well known and chemically well defined; (3) they must have the property of solubilizing both water- and fat-soluble substances; and (4) it must be possible to vary the chemical and the physical nature of the resulting solutions within wide limits when needed. It seems, therefore, natural that the vehicles should be nonpolar–polar compounds having their principal counterparts in living Nature[1-10]. For experimental studies, compounds of varying nonpolar–polar behaviour can be selected, either from the biologically active, natural nonpolar–polar substances or from the technical products known as detergents (cf. refs. 4, 5, 8 and 10). (From the beginning of 1947 until 1951, Prof. P. Ekwall (Institute for Physical Chemistry, Åbo Akademi, Turku, Finland) acted as chemical adviser in our studies in the field of aqueous solutions of association colloids[7].) Since 1946 I have systematically employed certain synthetic high polymers—for example, solutions of various polyethylene glycols (carbowaxes). It appeared that both these compounds and the so-called 'association colloids' which were brought into use later during our studies[7] have some common properties from the physico-chemical point of view[3,6,7].

Before investigations concerning the actual mechanism of experimental carcinogenesis could be started, some orientating tests were made (regarding the maintenance of the carcinogenic activity, differences in carcinogenic response of tissues when various types of nonpolar–polar vehicles are employed, the significance of the carcinogen and the colloid concentration, penetration and absorption of the carcinogen into various tissues, the possible transport mechanism, etc.). Some of the aspects are dealt with in the following. (Investigations have been carried out since 1945.)

Tumorigenic power. The first task was to test if the carcinogenic hydrocarbons solubilized by these nonpolar–polar mediators retain their tumorigenic activity. The tumorigenic power was tested using various strains of mice. In systematic studies, how-

ever, mice of our anonymous known strain employed in all our experiments were used. Up to the present, about 15,000 animals have been expended. For the orientating experiments, only relatively small series (ten to twenty mice in each subgroup) were at our disposal. The reasons for this were two-fold: the wide scope of the programme, and post-war difficulties in Finland. In the actual experiments, larger series (fifty to two hundred mice in each subgroup) were employed (see refs. 9, 13).

A priori, it was far from certain that these nonpolar–polar mediators would retain their activity (cf. ref. 11, pp. 56–59). So far, a great number of different representatives of nonpolar–polar mediators (both ionic and non-ionic ones) has been studied. It has now been established with certainty that carcinogens retain their carcinogenity and induce cutaneous[1–3,6,9,12], fore-stomach[3,6,12] and subcutaneous[2,9] tumours. In addition, there are significant differences in the average response when different vehicles are employed. Further, tumours can be induced by applying only a fraction of the quantities of the carcinogen reported in the literature.

Cutaneous tumours developed with a concentration, for example, of 0·0045 per cent of 9,10-dimethyl-1,2-benzanthracene in aqueous solutions of sodium lauryl sulphate[3,6,9]. The average time of response decreased with increasing concentration of the nonpolar–polar compound, and the fact that this time decreased at first faster with higher dilutions, and then more slowly, seems to indicate that the physico-chemical nature of the vehicle is important. The concentration of the nonpolar–polar substance is significant when the carcinogen concentration is low. At higher carcinogen concentrations, already at 0·009 per cent dimethyl-benzanthracene, the colloid concentration seems to be of secondary importance. These observations may perhaps be interpreted as indicating that the concentration, for example, of 0·03 per cent dimethyl-benzanthracene (a usual concentration in experimental work) is, in general, high enough to avert variations depending on differences in the physico-chemical nature of nonpolar–polar vehicles. Furthermore, these observations indicate that one has to use relatively low carcinogen concentrations when the significance of well-defined vehicles is studied[9].

Fore-stomach tumours developed in feeding experiments with a total dose of 0·6–4·0 mgm. dimethyl-benzanthracene per mouse when various types of aqueous solutions of detergents acted as mediator, and on an average of 1·6 mgm. when polyethylene glycols were used[3,6,12].

Penetration and absorption of the carcinogen. As to the skin, fluorescence studies indicated, first, that 3,4-benzpyrene, as well as other carcinogens, solubilized by aqueous solutions of various nonpolar–polar compounds, easily penetrate into the cutaneous elements[1–3,6,9,12], and secondly, that the localization and distribution of benzpyrene or its blue fluorescent metabolites, shortly after painting on the skin, depend on what types of nonpolar–polar substances are used[9]. The characteristics of the mediator substance seem to affect the rate at which the carcinogen is absorbed by the skin and the pathways for the passage of the carcinogen through the skin[3,6,9]. In addition, it appeared that benzpyrene can penetrate directly into the living epidermis and dermis in newborn mice when the carcinogen is applied before the tenth hour of life, that is, before the development of the pilo-sebaceous apparatus[3,14].

As to the gastrointestinal tract, gastric absorption of 3,4-benzpyrene was studied following gastric instillation of a single dose of the hydrocarbon. No signs of absorption or penetration by benzpyrene of the gastric glandular mucosa were observed after administration of the hydrocarbon in fat and oils. This is understandable, because little or no fat is absorbed by the glandular stomach wall under normal conditions. On the contrary, for penetration into this region the physico-chemical nature of the mediator substance is decisive. With substances possessing nonpolar–polar properties a weak penetration is observed if the lipophilic characteristics predominate, and a strong penetration if the hydrophilic characteristics are predominant. This was first observed using water-soluble polyethylene glycols[15]. Later it appeared that both these compounds and aqueous solutions of the actual association colloids (namely, soaps and soap-like substances) cause penetration into the gastric glandular mucosa[3,6,12,16]. Aqueous solutions of certain natural biological nonpolar–polar substances, such, for example, as those of bile acid salts and of higher fatty-acid salts, also cause penetration of benzpyrene into the glandular mucosa of the stomach[3,6,16].

Observations on the transport mechanism of the carcinogen. The mechanism determining the distribution in the body of carcinogenic hydrocarbons is a complicated phenomenon. However, certain facts suggest it being likely that the absorption (cf. also the preceding) and the transport mechanism of these substances are in some way linked to those of lipids. However, comparatively little is known about the physical state in which the carcinogen—shortly after its administration to the experimental animal—travels in the aqueous fluids of the body. After having examined the influence of some agencies (histamine administration, X-ray radiation of certain regions of the body) upon the behaviour of the so-called chylomicrons, that is, mobile visible lipids of the blood (cf. ref. 17), it was observed, first, that large amounts of benzpyrene or its blue-fluorescent metabolites exist in the content of the mesenteric lymphatics and in that of the thoracic duct after gastric instillation of the carcinogen[3,6], and secondly, that benzpyrene moves in the blood stream, at least to some extent, in association with chylomicrons[18]. It was also possible indirectly to confirm this by preparing 'artificial chylomicrons' containing various nonpolar–polar substances, globulins and 3,4-benzpyrene. If the resulting solutions contain certain biological nonpolar–polar compounds in varying suitable proportions, the size and the behaviour of these particles can be changed within wide limits when needed[9]. Further, parenterally administered fat, if emulsified with nonpolar–polar substances, enters the blood stream in the form of small visible particles, so-called lipomicrons, the physical state of which most probably is similar to that of the alimentary chylomicrons[19]. This happens also when large amounts of these nonpolar–polar compounds are painted to the skin of mice[6]. It is possible that the observations presented here may throw additional light on the problem how experimental remote tumours 'sediment' themselves.

Morphological changes induced by nonpolar–polar compounds. Ever since the recognition of skin carcinogenesis, attention has been paid to various changes in cutaneous elements as well as to the interaction between such changes caused by carcinogenic tars and hydrocarbons (see review in ref. 11, pp. 159–163). Already during the orientating experi-

ments of the present series with water-soluble polyethylene glycols[2,3,6], and later also in connexion with aqueous solutions of other detergents[3,6,8], it appeared that some of the mediators induced different types of epilation phenomena from those usually observed in skin carcinogenesis. In the present phase of the studies, it is certain that some of the nonpolar–polar compounds, without any known carcinogen, can cause morphological alterations in various cutaneous structures. For example, painting of the skin with the non-ionic polyoxyethylene sorbitan mono-oleate ('Tween 80') with a high hydrophile–lipophile balance value (cf. ref. 8) caused distinct alterations, especially in the subcutaneous adipose tissue[10]. On the other hand, another non-ionic detergent, sorbitan monolaurate ('Span 20'), with much lower hydrophile–lipophile balance value induced alterations both in the epidermis and dermis: enlargement of the individual cells, increased mitotic ratio, distinct thickening of the epidermis, destruction of the pilosebaceous apparatus, changes both in the intercellular matrix and in the connective tissue proper, dilatation of capillaries, degenerative changes in the vascular walls, etc.[9,13].

Using systematically selected nonpolar–polar compounds (for example, synthetic detergents) and high polymers (for example, polyethylene glycols), without any known carcinogen, it is possible to induce (within wide limits) various types of morphological changes in epidermis, dermis, or in both (as well as in some remote organs), in experimental animals, some of which are seen in connexion with carcinogenesis. Taking into account, first, the principles according to which certain of these compounds have been selected (for example, what is known about interactions between synthetic detergents as well as high polymers and various proteins[10]), and, secondly, what is known about connective tissue physiology and pathology, it is possible to throw additional light to the mechanism and pathogenesis of some of these alterations. Here we have at hand a better method for distinguishing the influence of a well-defined carcinogen from that of a well-defined vehicle.

Mechanism of experimental skin carcinogenesis. After these orientating studies, some observations upon the pathogenesis of experimental skin carcinogenesis may be considered. It has been reported that new-born mice (2–10 hr. after birth) are refractory to a single application of the carcinogen. The absence of pilo-sebaceous apparatus and also the thicker epidermis of new-born mice would explain the ineffectiveness of the carcinogen for penetration and tumour formation. In our studies the co-carcinogenic action of croton oil (cf. ref. 11, pp. 151–164) on the skin of new-born mice painted once with 9,10-dimethyl-1,2-benzanthracene during the first 10 hr. of their life was tested[3]. As a result cutaneous tumours do not develop, though the carcinogen easily penetrates into the cutaneous elements (*loc. cit.*). The reason for this seemingly negative result must thus be found elsewhere[9]. Following this work, series of adult mice received a single painting of 9,10-dimethyl-1,2-benzanthracene solubilized by various nonpolar–polar compounds. After this, croton oil treatment was carried out in the usual manner. The co-carcinogenic effect of this mixture became apparent as expected beforehand[9]. Taking into account the nature and morphology of the alterations in the skin induced by certain nonpolar–polar compounds, in another series of adult mice some of these compounds (for example, 'Span 20') were employed as co-carcinogens. As a result, cutaneous tumours developed at the site of painting[9,13]. These compounds are favourable for this kind of experiment because they do not induce cutaneous tumours when used without any known carcinogen. In other words, a considerable number of well-defined and biologically active colloid-forming compounds (both ionic and non-ionic) can serve as co-carcinogens as effectively as croton oil. (It is of interest that croton oil also contains several nonpolar–polar compounds which are able to react, for example, with proteins.) A large series of other well-defined co-carcinogenic agents is already under test. The results available so far point in the same positive direction[9]. To sum up, a new group of chemically and physico-chemically well-defined co-carcinogenic compounds has been discovered.

Accordingly, it would seem that the existence of a 'solvent effect' has become apparent in several different ways. We are continuing investigations on the following lines: (1) to search for powerful co-carcinogens from the large series of well-defined and well-known natural and synthetic nonpolar–polar compounds, high polymers, etc., having certain effects upon different biological systems; (2) to study the specific mode of action upon living matter of each of the principal different types of these agents. Employing series of systematically selected well-defined co-carcinogenic compounds with known influences upon various tissue elements, something of the tumorigenic property of the 'actual' carcinogen can gradually be transferred to these co-carcinogens. In this way it may be possible to investigate, among other matters, what is meant by the present concepts 'carcinogenic' and 'co-carcinogenic', what types of morphological and chemical (analysed, for example, with X-ray diffraction and biochemical methods) alterations in the elements of origin for tumour formation are essential, as well as interactions between parenchymal and stromal reactions during tumorigenesis—that is, the power to induce tumours under controlled conditions—and thus to throw more light on the biological processes, as a result of which experimental tumours develop.

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LETTERS TO THE EDITORS

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Effects of Ribonuclease on the Metabolism of Living Root-Tip Cells

Using ribonuclease as an analytical tool, Gale and Folkes[1] have recently brought forward new evidence for the hypothesis that ribonucleic acid plays an important part in protein synthesis[2,3]. A recent report, by Kaufmann and Das[4], that ribonuclease induces mitotic abnormalities in root-tip cells, shows that the enzyme actually can penetrate into living root-tips. These findings led to the present study on the effects of ribonuclease on the metabolism of nucleic acids, protein and respiration in onion root-tips. The experiments have been performed with the technical help of J. Brygier, E. Baltus and F. Vanderhaeghe.

When intact onion root-tips are treated with crystalline ribonuclease (1 mgm./ml.) for a few hours prior to immersion in water containing a labelled amino-acid (radioactive glycine or phenylalanine), there is considerable inhibition of the incorporation of amino-acid into the proteins: a 50 per cent inhibition is observed after pre-treatment for 1 hr. with ribonuclease, and it reaches almost 90 per cent after treatment for 3 hr. with the enzyme. These biochemical results have been confirmed by using an autoradiographic method: as seen in Figs. 1 and 2, treatment for 3 hr. with ribonuclease considerably reduces the uptake of labelled phenylalanine into the cells. Inactivated crystalline ribonuclease showed no effect on the incorporation of the labelled amino-acids into the proteins of the root-tips.

Very different results are obtained when the incorporation of labelled adenine in the nucleic acids is studied: treatment with ribonuclease first increases the incorporation of adenine into ribonucleic acid, the increase reaching 60 per cent for a 3-hr. period. Incorporation then steadily decreases, so that in root-tips treated for 20 hr. with ribonuclease, 80 per cent inhibition is found. As regards deoxyribonucleic acid, the incorporation of labelled adenine is immediately reduced: the inhibition reaches 30 per cent during a period of 1–3 hr. and it becomes practically complete after 20 hr. These observations suggest that ribonuclease immediately slows down deoxyribonucleic acid synthesis, leading to the cytological abnormalities described by Kaufmann and Das[4], while it first stimulates, then inhibits ribonucleic acid metabolism.

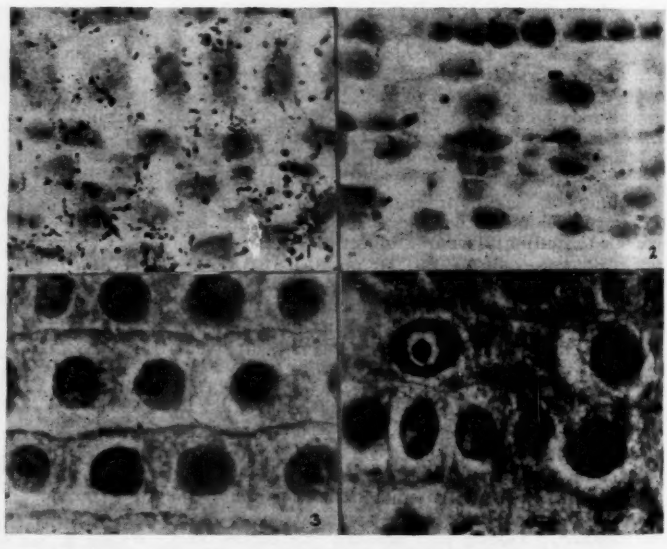
In contrast to these striking changes in protein and nucleic acid metabolisms, the oxygen consumption of the root-tip meristematic tissue remains unaffected by ribonuclease, even after treatment for 15 hr.

While the oxidative activities of the mitochondria thus apparently remain normal, phosphorylations are effected by the ribonuclease treatment: the inorganic phosphate content drops by 20 per cent during the first 3-hr. period, without any further changes. At the same time, acid-labile organic phosphate (presumably adenosine triphosphate) shows a 30 per cent increase during the first 3 hr. of the ribonuclease treatment and remains constant afterwards. These results probably mean that adenosine triphosphate is not utilized and thus accumulates, when protein and deoxyribonucleic acid metabolisms are inhibited by ribonuclease.

Ribonucleic acid, when estimated spectrophotometrically according to the method of Ogur and Rosen[5], shows a 20 per cent drop after the root-tips have been treated for 3 hr. with ribonuclease; there is no further decrease afterwards, even after 18 hr. Soluble nucleotides seem to drop slightly at the beginning (1–3 hr.), then steadily increase, finally reaching a value 40–50 per cent above controls after 18 hr. It should be pointed out, however, that classical methods of estimation of ribonucleic acid might be misleading if the nucleic acid of the cells is partly degraded by ribonuclease. It seems, nevertheless, that the strong inhibition of protein metabolism is not linked to any extensive degradation of ribonucleic acid.

This conclusion is confirmed by cytochemical observations on cells treated with ribonuclease: after Unna staining, the cells of the outer layers are more basophilic than normally after 3 hr. in ribonuclease. The increased basophilia is due to ribonucleic acid, as shown by the ribonuclease test[3]; it is thus likely that the enzyme first induces a synthesis of ribonucleic acid in the external cells. Later on, after 6 hr., for example, this outer layer of cells loses its basophilia almost completely.

An interesting point is that when sections of roots previously treated *in vivo* for 3 hr. with ribonuclease are stained with Mazia's[6] method for proteins, an empty space becomes visible around most of the nucleoli (Figs. 3 and 4). This finding might



Track-radioautograph of onion root-tip cells incubated in radioactive phenylalanine. Control (1) and after treatment by ribonuclease (2)
Sections of onion root-tip cells stained by Mazia's method. Control (3) and after treatment by ribonuclease (4)

mean that, as proposed by Caspersson[2], the nucleolus plays a very important part in protein synthesis, in agreement with the experimental data obtained in this laboratory by A. Ficq[7].

These results, in showing that ribonuclease produces a very strong inhibition of amino-acid incorporation into the proteins of living cells, bring fresh evidence for the view that ribonucleic acid is intimately concerned with protein synthesis. The accumulation of adenosine triphosphate in the treated cells as well as the fact that ribonucleic acid only partly disappears after treatment by ribonuclease agree well with Dounce's hypothesis[8] that a phosphorylated form of ribonucleic acid is involved in a template mechanism of protein synthesis. It should finally be pointed out that ribonuclease, when acting on living cells, exerts effects comparable to those of the removal of the nucleus in unicellular organisms[9]; for in such cases, ribonucleic acid decreases together with protein anabolism, while adenosine triphosphate increases and oxygen consumption remains unaffected.

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Inactivation of the Chromatophore-expanding Activity of Pituitary Extracts by Ascorbic Acid

In experiments dealing with the connexion between the adrenocorticotrophic hormone (ACTH) and intermedin, we have tried to protect the hormone from inactivating oxidation by the addition of substances with a low redox potential. Among others, ascorbic acid (Merck) has been used, as it is well known that it protects for several hours from oxidation, for example, highly diluted solutions of sympathins. But contrary to expectation, it was found that after the incubation of an adrenocorticotrophic hormone preparation of Schering in a Ringer solution containing 10 mgm./100 gm. ascorbic acid at + 4° C. overnight, its original chromatophore-expanding activity was found to be reduced to 2 per cent.

We have therefore tried in a number of experiments to get some information upon the mechanism of the reaction between ascorbic acid and the active polypeptide. Experiments were carried out on Voegtlin–Standard powder, on ACTH–Schering, and on corticotrophin-*B* 52*R*6239 (kindly supplied by N. Brink, Merck). The chromatophore-expanding activity of the extracts was estimated from the permeability to light of isolated frog skin in a Pulfrich photometer. By this method a straight dose – response curve can be obtained by plotting the logarithm of the dose against the ratio (Δ extinction of each dose)/(Δ extinction of a standard dose). The slope of this curve is about 1, λ about 0·1. Using an ACTH preparation of Messrs. Schering (1 mgm. = 3 I.U. ACTH) the threshold was 0·001 μgm. of the dry extract per ml. Ringer solution, for corticotrophin *B* (1 mgm. = 150 I.U. ACTH) between 0·0002 and 0·0005 μgm. per ml. Ringer. To compare the activities of preparations treated in different ways, the six-point assay technique has been used. The following results have been obtained.

(1) A depletion of the chromatophore-expanding activity of Voegtlin powder by 90 per cent after 0·5 μgm. (= 10 melanophore-expanding units, M.E.U.) has been incubated at room temperature in 10 ml. Ringer solution containing 10 mgm./100 gm. ascorbic acid (*p*H 6·6) for 1 hr.; under similar conditions a depletion of the chromatophore-expanding activity of ACTH–Schering (3·95 μgm. (= 900 M.E.U.) per ml. ascorbic acid Ringer) by 70 per cent after 2 hr., by 85 per cent after 4 hr., by 96 per cent after 20 hr. incubation.

The chromatophore-expanding activity of corticotrophin-*B* (5 μgm. (= 1,880 M.E.U.) per ml. ascorbic acid Ringer) shows in several experiments a mean depletion by 22 per cent after 4 hr., 52 per cent after 12 hr. and 88 per cent after 28 hr. when compared with the spontaneously declining activity of the control solutions containing no ascorbic acid. Lower concentrations of ascorbic acid, for example, 0·1 mgm./100 gm., also produced inactivation. Inactivation occurred whether atmospheric oxygen was present or not.

(2) If ACTH–Schering was incubated in a solution containing dehydroascorbic acid and *l*-gulonic acid, the depletion after 20 hr. was only 58 per cent against 99·16 per cent with ascorbic acid.

(3) If the pituitary extracts were incubated for 2 hr. in solutions containing ascorbic acid plus cystein, or thiourea, or 8-hydroxyquinoline, their activity on frog skin was reduced by approximately 40 per cent of that of the control. But this depletion did not increase, although the incubation was prolonged for another 18 hr. Cystein, thiourea and 8-hydroxyquinoline themselves did not significantly influence the chromatophore-expanding action of the pituitary extracts tested.

Details of this work will be published elsewhere.

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Interrelationships between a Yeast and a Bacterium when growing together in Defined Medium

Since the introduction of solid medium, the isolation of micro-organisms in pure culture, formerly a matter of considerable difficulty, has become a relatively easy process. The numerous studies of micro-organisms in pure culture which resulted have enabled the science of microbiology to develop rapidly. In Nature, however, micro-organisms are rarely found in pure culture, and there is a need for investigation of the growth and metabolism of organisms growing in association with each other. Woods[1] has recently stressed the need for such research. The present study of a yeast (*Saccharomyces cerevisiae*) and of a bacterium (a *Lactobacillus* species) growing separately, and also when growing in association with each other in defined media, was commenced approximately two and a half years ago and is concerned mainly with

the nutritional requirements of the micro-organisms. A number of interesting relationships between the organisms when in mixed culture have been observed.

The medium employed in these studies was nutritionally adequate for each of the two micro-organisms and contained: glucose (6 per cent), casein hydrolysate (1 per cent) and the following growth factors: inositol 10 μgm./ml., D-biotin 2·2 mμgm./ml., calcium-D-pantothenate 2 μgm./ml., thiamine 2 μgm./ml., pyridoxin hydrochloride 2 μgm./ml., nicotinic acid 2 μgm./ml. and pteroylglutamic acid 100 mμgm./ml. In pure culture, the yeast requires an exogenous source of inositol, biotin and pantothenic acid: thiamine, nicotinic acid and pyridoxin are stimulatory. The *Lactobacillus* requires biotin, pantothenic acid, nicotinic acid, thiamine and folic acid (pteroylglutamic acid).

The *Lactobacillus* failed to grow in the defined medium when either nicotinic acid or thiamine was absent. In mixed culture with the yeast, however, the lactobacilli grew moderately well in the absence of either of these growth factors, but only when the concentration of the other growth factors in the medium was considerably reduced, that is, as compared with the concentration normally present. Thus, in the absence of nicotinic acid, the growth of the lactobacilli in mixed culture was greatest when the other growth factors were present at approximately one-twentieth of the concentration normally employed. In such cultures growth of the yeast is restricted, and it would appear that the organism is synthesizing nicotinic acid, or some substance which can replace the nicotinic acid requirement of the *Lactobacillus*, and secreting it into the medium where it becomes available to the *Lactobacillus*, which is thus able to grow. It was shown that the yeast when growing alone in such media did in fact secrete such a substance in the medium; further examination of the yeast culture filtrate showed that the active substance was nicotinic acid itself or its amide. Addition of this yeast culture filtrate to medium not containing nicotinic acid and inoculated with the lactobacilli enabled the bacteria to grow, whereas no growth occurred in this medium when yeast culture filtrate was not added.

Similar interrelationships were observed in connexion with the purine requirements of the *Lactobacillus*. The yeast does not require either purines or pyrimidines for growth, whereas the *Lactobacillus* needs an exogenous supply of adenine, guanine and uracil—or hypoxanthine together with uracil. The *Lactobacillus* failed to grow in media lacking adenine or guanine or both, but did so when in mixed culture with the yeast: such growth, however, occurred only in media in which the vitamins were present at sub-optimal concentrations, that is, media in which yeast growth was restricted.

Eight interrelationships were observed in connexion with the amino-acid requirements of the *Lactobacillus*. Its requirements were determined in a glucose medium in which amino-acids were the sole source of nitrogen, and the organism was found to be exacting to ten of the acids: two other amino-acids were stimulatory. In media lacking any one of eight of these twelve amino-acids the *Lactobacillus* grew to a very limited extent or not at all, whereas in mixed culture with the yeast the bacterium was able to grow to an appreciable extent; such interactions were most marked in media lacking aspartic acid, tryptophan, glycine, alanine or lysine, and only occurred when the vitamin concentration was sub-optimal (approximately one-tenth of the concentration normally employed), that is, in media in which yeast growth was restricted. The filtrates of pure yeast cultures grown in such media were shown by chromatographic or other methods to contain the missing amino-acid or some substance which could replace it.

In all, some thirteen inter-relationships between the yeast and the *Lactobacillus* have so far been observed, and in each of them the yeast appears to be the active organism, that is, to have synthesized the missing substance essential for the growth of the *Lactobacillus*. The substances concerned are widely different in nature and include vitamins, purines and amino-acids. It is suggested that other methods of restricting growth of micro-organisms may well repay investigation, for example, alteration of *p*H or of degree of aerobiosis or of incubation temperature.

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Effect of Streptomycin on the Host – Pathogen Relationship of a Fungal Phytopathogen

In these laboratories we have found tomato and potato suitable subjects for the study of the effect of streptomycin on host–pathogen relationships and have observed an interesting effect of this antibacterial substance on the course of development of infections due to *Phytophthora infestans*. Bonde[1] has reported a similar effect from the absorption of terramycin hydrochloride through the cut stems of Katahdin potato plants, but failed to obtain an effect with streptomycin even at concentrations of 100 μgm./ml.

We applied the antibiotic via the root system by exposing 35-day old plants to nutrient solutions containing different concentrations of streptomycin calcium chloride for one week. The effect on the reaction of the host to infection was examined by inoculation of detached leaves with a zoospore suspension applied in filter-paper disks and incubated at 20° C. in a moist chamber. In one experiment whole plants were sprayed with a zoospore suspension.

The concentration of streptomycin in leaf tissue was determined by bio-assay, and the toxicity of the antibiotic to the pathogen was tested *in vitro*.

The main results were as follows. In both potato and tomato a marked protective effect was observed at concentrations which had no effect on the vegetative development of the plants. In the case of tomato, even 4 μgm. of streptomycin per ml. of nutrient solution completely checked the disease. However, infection itself is not prevented by the presence of streptomycin in the tissue, but spread of the parasite is restricted after contact with the host plasm in contrast to the diffuse spreading noted in the untreated plants. The parasitized host cell dies and, very often, the surrounding tissue becomes chlorotic.

The concentrations supplied and those in extracts of treated plants have been shown to have no significant effect on zoospore development or germination of the parasite. *Phytophthora* mycelium tolerated streptomycin at concentrations even of

200 μgm./ml. However, slight depression of growth was observed at 8 μgm./ml.

The suppressive effect on the growth of the pathogen in living tissue was tested further by inoculation of cut tuber surfaces treated with streptomycin solutions and rinsed to remove free antibiotic. It was found that higher concentrations were required to obtain a checking effect in this work. A slight depression of sporulation occurred at 60 μgm./ml., and complete inhibition was observed at 200 μgm./ml.

It appears that when absorbed by the host cell streptomycin is firmly held, since there is little movement to tissue developed after the plant is removed from treated to normal nutrient solutions. Thus in one series of plants, *Phytophthora* developed rapidly on axillary shoots, but there was a slight reduction of sporulation on the basal leaves indicating that some translocation may have occurred.

There is a difference in response between organs of treated plants, the effect being more marked in leaves of both potato and tomato than in tubers or fruits. There are indications that young leaves respond more definitely than older ones.

Streptomycin does not exert a general protective effect against fungal pathogens. Even when treated with a concentration of 100 μgm./ml., many potato plants were severely attacked by powdery mildew (*Erysiphe solani Vanha.*).

If one assumes that streptomycin is evenly distributed within the cell and total extraction of streptomycin is obtained, the concentrations demonstrated by bio-assay of tissue extracts cannot be responsible for the effects observed. It would appear, then, that the antibiotic is either: (*a*) unevenly distributed in such a way that the parasite contacts lethal concentrations at the surface of the cell where parasite and host plasm first establish contact; or (*b*) it induces some change which alters the host–pathogen relationship in such a way as to confer some degree of resistance to the host.

Further experimental work will be required for the elucidation of the mechanisms involved in these changes of the host–pathogen relationship.

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Reaction between Phthalein Dyes and Heated Foodstuffs

A tentative method for the estimation of the quality of soybean oil meal, based on varying ability of different meals to absorb or react with phenolphthalein, has been briefly described[1]. Properly heated meals absorbed or reacted with significantly more phenolphthalein than under-heated samples, and over-heated samples somewhat more than the properly heated ones.

Since then, a variety of other dyes has been tried, but it was found that only phthaleins like phenolphthalein, phenol red, bromothymol blue, and cresol red reacted in this characteristic way. Other dyestuffs tried—methyl red, methylene blue, fuchsin—were absorbed to about the same extent regardless of the heat treatment of the meals. Further, it was found that the absorption of the phthalein dyes was rather independent of the fineness of the sample. From these facts it is concluded that there is not only an absorption but also a staining reaction between the phthalein dyes and substances in the soybean oil meal, especially those formed by heating (the Browning reaction).

From the experiments with the different phthalein dyes it has been found that phenolphthalein under given conditions best distinguishes between under-heated, properly heated and over-heated meals. It has, however, the disadvantage of not being stable when made alkaline in presence of substances present in soybean oil meal. The solution must be made alkaline immediately before the reading in the photometer. It is supposed that the substances in the alkaline medium form products which react with phenolphthalein. Cresol red is much more stable, and when using this dye the method has been simplified as follows: 400 mgm. samples are weighed in centrifuge tubes and 10 ml. freshly mixed reagent solution (one part of an alcoholic solution of cresol red, 2 mgm./ml., and nine parts of 0·1 *N* hydrochloric acid) are added. The tubes are shaken for one hour and then centrifuged. One ml. of the supernatant is added to 10 ml. 0·02 *N* sodium hydroxide. The colour is read in a spectrophotometer at 5,700 A.

Some results from the experiments with this method are given in Table 1. From this it is seen that there is a marked tendency of heated meals to absorb (react with) more cresol red as compared with under-heated samples.

Table 1. Absorption of Cresol Red by Different Soybean Oil Meals

Character of the soybean oil meal*	Number of meals tested	Photometer readings (% transmission)	Mgm. cresol red absorbed per gm. meal
Much under-heated	6	9–15	2·5–3·0
Under-heated	4	21–28	3·3–3·8
Properly heated	8	39–52	4·0–4·3
Over-heated	2	54–55	4·4–4·5

* As indicated from laboratory determinations and chick growth experiments.

This cresol red test has also been performed with some samples of rape seed meal, linseed meal and dried milk. Even with these, correlation between heat treatments and cresol red absorption was found. Details of these experiments will be published elsewhere.

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Induction of Tumours with 1-(2-Tolylazo)-2-naphthol (Oil Orange *TX*)

Peacock[1] induced hepatomas in seven of seventeen mice surviving subcutaneous injection of oil orange *E* (1-benzeneazo-2-naphthol) for more than fourteen months. This substance was then in use as a food dye. Clayson[2] has since suggested that it might be active by virtue of its *in vivo* reduction to 1-amino-2-naphthol. If this be so, it was thought that other compounds capable of being reduced to this amino-naphthol might be carcinogenic.

1-(2-Tolylazo)-2-naphthol was purified by chromatography on alumina. 3 mgm. of this compound as a 3 per cent solution in arachis oil were injected subcutaneously into albino mice twice a week for fifty weeks. Of thirteen mice which survived for more than forty-six weeks, three developed spindle-cell sarcomas at the site of injection at 46, 53 and 61 weeks respectively (Table 1). In another three mice, tumours of the intestine were found. The first of these was detected by palpation before the mouse was killed, 62 weeks after the commencement of treatment. It was an adenocarcinoma arising in the region of the ileo-cæcal junction, probably in the cæcum, invading through the muscular coat and spreading extensively in the omental lymphatic vessels. There was a secondary deposit in a para-ileal regional lymph node. On microscopical examination in another mouse killed after 69 weeks, an adenocarcinomatous polyp was seen in the cæcum close to the junction with the ileum. At the base of this tumour there was invasion of the muscular coat, and a nodule of adenocarcinoma, probably situated in a lymphatic vessel, was found in the omentum. The third tumour, which arose in a mouse treated for 65 weeks, was detected macroscopically as a thickening of the small intestine. It proved to be an adenomatous polyp of such irregular structure that early malignant change was suspected, but neither invasion of muscle nor metastasis was found.

Table 1

Experimental mice				Control mice	
Weeks of survival after beginning treatment	Local sarcoma	Intestinal tumour	Other findings	Weeks of survival after beginning treatment	Findings
46	+			46	
53	+		Lung adenoma	46	
54				59	
61	+		Lymphoma		
62				64	Lymphoma
62		+		64	Lymphoma
65		+	Lymphoma	64	Lymphoma, lung adenoma and luteoma
67				64	
69		+		70	
69			Lung adenoma	70	Lung adenoma
72			Lung adenoma		
84			Lung adenoma and mammary cancer	77	
84			Lymphoma and lung adenoma	80	

Lymphomas, lung adenomas and mammary cancer occurred in mice treated with the dye and in others injected with arachis oil alone (Table 1); but in the latter no local sarcomas and no intestinal tumours were found.

The livers of mice treated with 1-(2-tolylazo)-2-naphthol showed no proliferative changes. This is in contrast with Peacock's experiment where hepatomas, but no other type of tumour, were induced with the closely related chemical 1-benzeneazo-2-naphthol. In the present experiment the dye was given by subcutaneous injection of an oily solution. It seems unlikely that its carcinogenic activity would be suppressed if it were given by mouth, a point which is already under test. Therefore the use of the dye (oil orange *TX*) as a food colorant should be discontinued.

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A Brain Extract as a Substitute for Platelet Suspensions in the Thromboplastin Generation Test

The test described in 1953 by Biggs and Douglas[1] has proved a valuable technique for the study of the generation of plasma thromboplastin, and in the diagnosis of the various hæmorrhagic states due to defects at this level. Of the three ingredients for the 'incubation mixture', as originally described, only the preparation of a consistently satisfactory platelet suspension is troublesome and time-consuming enough to cause difficulties for those not constantly using the test. We have devised a modification, which we feel allows a higher degree of accuracy, as well as solving this problem and eliminating the need for siliconized glassware.

A standard human brain thromboplastin, prepared by acetone drying, is further washed with acetone until free of cholesterol, as judged by a negative Liebermann–Burchardt reaction. When 1 gm. of the dried powder is extracted at room temperature with approximately 50 ml. of chloroform, more than 300 mgm. of active material is obtained by evaporation of the filtrate. This gummy residue is finely homogenized in 50 ml. of 0·85 per cent sodium chloride. An approximately 1 : 100 saline dilution of this concentrate, substituted for the platelet suspension, gave 'peak' times of 10 ± 1 sec. in thromboplastin generation tests of plasmas and sera from twenty normal individuals; as with platelets,

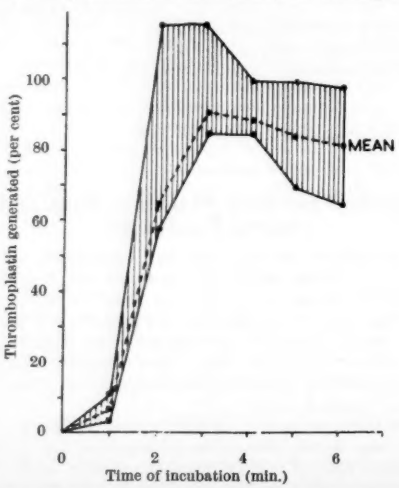

Fig. 1. Shaded area indicates range obtained with plasma and serum of each of twenty normals and same batch of extract 1 : 100

this 'peak' is reached in 3–5 min., and the optimal 'alumina' plasma and serum dilutions are 1 : 5 and 1 : 10 respectively, as recommended by Biggs and Douglas.

When frozen, the concentrated saline suspension remains stable for at least twelve months; it may be thawed and re-frozen repeatedly without loss of activity. The exact dilution for use should be determined for each batch of extract.

This modification was evolved in the process of work[2] on an extract for therapeutic use in thrombocytopenic states. It has proved entirely satisfactory in the diagnosis of hæmophilia and Christmas disease.

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Influence of Ethylenediamine-tetra-acetic Acid on the Excretion of Zinc by the Rat

The administration of ethylenediamine-tetra-acetic acid (versene, sequestrene) causes increased urinary excretion of calcium, iron, lead and other metallic ions[1]. We became interested in this chelating agent as a possible means for reducing zinc stores and thus hastening the onset of deficiency in rats maintained on a diet low in zinc. Information on the effect of ethylenediamine-tetra-acetic acid on zinc metabolism was also required in planning an investigation of the excretion of recently absorbed zinc-65. Stability constants indicate[2] that zinc forms one of the most stable complexes with ethylenediamine-tetra-acetic acid, but we are not aware of any previous experiments to test its action on body stores of zinc, apart from a brief reference to unpublished work by Mager[3].

The present report concerns a preliminary investigation of the effect of ethylenediamine-tetra-acetic acid on the urinary excretion of zinc in rats. The calcium disodium salt of ethylenediamine-tetra-acetic acid was injected intraperitoneally into young adult male rats in doses of 100 mgm. per kgm. daily for three days. In experiment 1, four rats were kept in a stainless steel metabolism cage and the pooled urine collected each day for 18 hr. after the injection, and once for the following 6 hr. A control sample was collected on the day before injections began. During the control period and the first test period, the rats received distilled water but no food. Thereafter, a synthetic diet (modified from Day and McCollum[4]) containing less than 0·5 μgm. zinc per gm. was supplied continuously. In experiment 2, the animals received

Table 1. Influence of Ethylenediamine-tetra-acetic Acid on Urinary Excretion of Zinc

Sample	Collection time (hr.)	Mean urine zinc (μgm. per rat) Exp. 1	Exp. 2
Control	18	2·2	3·8
EDTA, 1st day	18	68·5	37·1
EDTA, 2nd day	18	69·5	61·0
Remainder of 2nd day	6	1·8	—
EDTA, 3rd day	18	155·2	75·7

Controls: Exp. 1: Urine from four rats collected for one 18-hr. period. Exp. 2: Urine from eight rats collected for three 18-hr. periods. Tests. Exp. 1: 100 mgm. per kgm. $CaNa_2EDTA$ per day—1st day in 5 per cent, 2nd and 3rd days in 2·5 per cent solution; Exp. 2: 100 mgm. per kgm. $CaNa_2EDTA$ per day in 0·83 per cent solution.

Table 2. Effect of Ethylenediamine-tetra-acetic Acid on Zinc Content of Ileum and Pancreas

Treatment and diet since weaning	Ileum No. of rats	Ileum Mean Zn (μgm. per gm.)	Ileum S.E. of mean	Pancreas No. of rats	Pancreas Mean Zn (μgm. per gm.)	Pancreas S.E. of mean
Controls						
Zinc-deficient	10	19·7	±1·8	6	18·5	±1·2
Deficient + 100 μgm. zinc per day	14	37·2	±2·6	12	25·7	±1·4
Fox chow	13	38·7	±1·7	10	23·9	±0·7
EDTA injection						
Fox chow; zinc-deficient for 3 days	4	29·7	±2·9	4	18·1	±3·1

Controls are mean values from unpublished experiments.

Purina Fox Chow (75 μgm. zinc per gm.) during the daily 6-hr. feeding period and were kept in the metabolism cages, with water but no food, for the 18-hr. collection period. Two groups of four rats each were used. Control samples were collected for three days previous to the injection of ethylenediamine-tetra-acetic acid. Results of urine zinc analyses by the method of Vallee and Gibson[5] are given in Table 1.

Intraperitoneal injection of the calcium disodium salt greatly increased urinary excretion of zinc. Very little zinc is normally excreted in the urine, and the range of values observed in experiment 2 was 1·6–5·9 μgm. zinc per 18 hr. Zinc mobilization occurred immediately after injection of ethylenediamine-tetra-acetic acid, and from the one determination for the final 6-hr. period in experiment 1, it seems that little excess zinc was excreted after the 18 hr. following injection.

After the last collection period, the following tissues from experiment 1 were analysed for zinc: stomach, ileum, pancreas, kidney, testis, epididymis, dorsolateral prostate, bone (tibia) and blood. All tissues except ileum and pancreas gave results within the normal range for rats fed on Purina Fox Chow—the diet of these rats before the experiment began. Ileum zinc approached that found in rats maintained for 5–8 weeks on the zinc-deficient diet (Table 2), while pancreas zinc in three out of four cases was equal to that found in such zinc-deficient rats. The reduced zinc concentration in pancreas and ileum was not unexpected, since zinc excretion normally occurs via the pancreas[6] and alimentary canal. The reduced intake and increased urinary excretion would decrease the need for this excretion route and thus lower the concentration of transient zinc.

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Histochemical Adaptation of Aryl Iodosoacetates

It has been possible to obtain cleavage of the 1,2 glycol linkage in tissue sections with a solution of phenyl iodosoacetate in glacial acetic acid[1], thus duplicating histochemically the chemical studies of Criegee and Beucker[2]. However, to establish definitely the reliability of aryl iodosoacetates as histochemical reagents, it was felt that several other compounds of this type should be examined in a similar manner.

Four aryl iodosoacetates were prepared by Willgerodt's general methods[3], namely, *p*-nitrophenyl iodosoacetate, *p*-tolyl iodosoacetate, *m*-tolyl iodosoacetate, 2,4 xylyl iodosoacetate. These compounds were then tested histochemically for 1,2 glycol cleavage using formalin-fixed sections (paraffin technique) of rat and rabbit intestine and kidney. Concentrations of these compounds in glacial acetic acid were used ranging from 0·001 *M* to saturation, with oxidation periods of 15 min.–3 hr. All reactions were performed at room temperature (27° C.), and the aldehyde radicals resulting from the cleavage were stained with leucofuchsin. The 0·02 *M* solutions suggested by Pausacker[4] for chemical cleavage of *iso*hydrobenzoin and used in the phenyl iodosoacetate experiments appeared to be the concentration of choice, while the period of optimal oxidation was between 1 and 2 hr. The histological picture was similar to the one obtained with phenyl iodosoacetate and resembled that of lead tetraacetate[5] although weaker and less precise.

These experiments would appear to indicate that aryl iodosoacetates as a group are adaptable to histochemical procedures, and although their use is still academic, they may be of value to histochemistry in due course.

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Chromatography of Tissue Histamine

Extracts of tissues exceptionally rich in histamine, such as ox pleura, ox liver capsule, and mast cell tumours from dogs[1], were prepared for ascending chromatographic estimation of histamine by simple extraction or by grinding the tissues with 10 per cent aqueous trichloracetic acid and centrifuging. Using as solvent mixture *n*-butanol : acetic acid : water (4 : 1 : 5), we observed that after spraying with the Pauly or the paranitraniline diazo-reagent two sharply defined spots appeared on the chromatogram of R_F = 0·11 and 0·65 (Fig. 1,*A*). Both spots contained material which when eluted with water or 0·01 *N* hydrochloric acid showed histamine activity on the isolated guinea pig ileum and on the blood pressure of the atropinized cat. Prior removal of the excess trichloracetic acid from the solution by ether extraction merely reduced the intensity of the fast-running spot. When an eluate of this fast-running spot (R_F = 0·65) was re-run in the same solvent as before, the histamine now remained entirely in its lower location (R_F = 0·11).

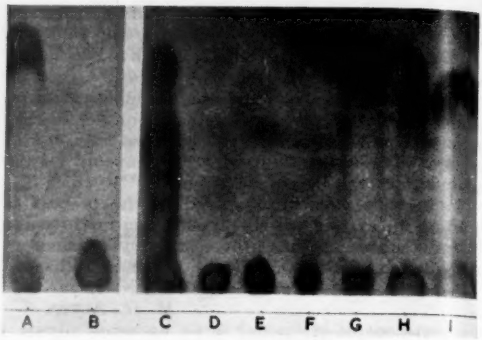

Fig. 1. Chromatograms developed with Pauly diazo-reagent for histamine. (*A*) Extract of dog mastocytoma in 10 per cent trichloracetic acid; (*B*) solution of histamine (100 μgm.) in water; (*C*) solution of histamine (100 μgm.) in 10 per cent trichloracetic acid; (*D*) solution of histamine (100 μgm.) in *N*/3 hydrochloric acid; (*E*) solution *C* after ether extraction; (*F*) solution of histamine (30 μgm.) in 10 per cent trichloracetic acid; (*G*) solution *F* with 300 μgm. arginine added; (*H*) solution *G* after ether extraction; (*I*) solution *F* with 100 μgm. each of arginine, lysine and ornithine added

At least three factors appear to be involved in the migration of histamine to the fast-running spot, namely: (1) the concentration of trichloracetic acid; (2) the concentration of histamine; (3) the presence of a basic amino-acid. First, pure histamine acid phosphate in water forms a compact spot at R_F = 0·11 (Fig. 1,*B*), but with increasing concentration of trichloracetic acid a 'trail' of histamine moves up the paper as far as the R_F = 0·65 area (Fig. 1,*C*). This is not a mere *p*H effect, for histamine in 0·33 *N* hydrochloric acid (Fig. 1,*D*) or in 10 per cent aqueous acetic acid does not migrate in this way. Trifluoracetic acid resembles trichloracetic acid in its mobilizing effect on histamine, recalling the similar effect of these acids on the chromatographic behaviour of adrenaline[2]. Removal of the excess acid from these solutions by ether extraction concentrates the histamine into a single compact spot at R_F = 0·11 (Fig. 1,*E*). Secondly, when the strength of the trichloracetic acid is kept constant, any increase in concentration of histamine in the mixture is followed by increased upward trailing from the slow-running spot (Fig. 1, cf. *C* and *F*). Thirdly, for complete separation of the two spots, the presence of at least one basic amino-acid is necessary. When an artificial mixture is made up containing pure histamine, trichloracetic acid and arginine, lysine or ornithine, the chromatographic pattern now exactly resembles that seen with tissue extracts, the histamine being divided between the two spots, R_F = 0·11 and R_F = 0·65 (Fig. 1,*G*); ether extraction of this mixture simply reduces the intensity of the fast-running spot (Fig. 1,*H*). When all three amino-acids are present in the mixture, the chromatogram shows inversion (Fig. 1,*I*).

It is thus possible that the remarkable ability of trichloracetic acid to extract histamine from tissues is related not only to its coagulative effect on protein but also to its participation in a loose complex containing histamine (probably as the trichloracetate) and basic amino-acids. Detailed analysis of the

original tissue chromatogram shows that arginine and lysine are in fact present and trail behind the fast-running spot of histamine.

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Fluorescent Substances in Chromatograms of a Mutant Stock of *Drosophila*

In chromatograms prepared from various *Drosophila* organs and from whole flies, seven different ultra-violet fluorescent substances have been described[1,2]. The concentrations of these substances were shown to vary in different mutant stocks of the fly. Flies carrying recessive mutants in the heterozygous state could be distinguished from wild-type homozygotes on the basis of their fluorescence patterns[3,4].

It seemed of interest to determine whether the characteristic features in the chromatogram of a mutant stock depend on the major mutant gene it carries, or whether other genetical factors may be involved in their determination. This investigation was based on an *ey*^{2} stock of *D. melanogaster*.

Chromatograms were prepared on Whatman No. 1 paper, by squashing the severed heads of female flies (age at least four days), which had been briefly immersed in 96 per cent alcohol and afterwards boiled for 2½ min. in distilled water. For preliminary examinations, one-dimensional ascending chromatograms of various lengths were developed in propanol – ammonium hydroxide. For quantitative determinations, two-dimensional ascending chromatograms of 29 cm.^{2} were developed in a dark room in butanol – acetic acid – water in the first dimension and in water-saturated collidine in the second dimension. Twelve heads of the wild-type laboratory stocks or fourteen heads of the *ey*^{2} stock were used for one two-dimensional chromatogram. All *ey*^{2}-flies utilized possessed eyes of reduced size. Animals entirely devoid of eyes frequently appear in the stock, but these were not analysed. The ultra-violet fluorescent spots were identified in the chromatograms by the light of a lamp with maximum radiation at 365 mμ. These spots and blanks of corresponding sizes, having received identical solvent treatment, were eluted in the dark room in 3 c.c. of distilled water each. The fluorescence of the solutions obtained was measured with a Farrand fluorometer using filters of maximum transmittance at 366 mμ and 440 mμ as primary and secondary, respectively.

The *ey*^{2} stock differed from two laboratory strains (Berlin and Canton *S*) in three fluorescent spots, which are here designated by the symbols of Hadorn and Mitchell[1]. *Fl* 4 ('blue') was stronger, *Fl* 5 ('yellow') was weaker and *Fl* 7 ('yellow') appeared much fainter than in the wild-type flies.

Males of *ey*^{2} stock were crossed to virgin females of each wild strain. The *ey*^{2} males obtained in the F_2 generation were again mated to virgins of the appropriate wild stock. This procedure was repeated to the seventh backcross generation. The *ey*^{2} gene, the expression of which remained unimpaired, was thus gradually transferred to a background of genes and cytoplasm from the laboratory stocks. All cultures were kept at 26·5° ± 1° C. After the seventh backcross to the Berlin strain, allelism of the *ey*^{2} gene carried in the original stock with that of the modified line was confirmed by a test cross.

Starting with the F_2 of the fifth backcross generation, *ey*^{2} females with a Berlin background were utilized for chromatograms. Their one-dimensional fluorescent pattern was by then indistinguishable from that of the Berlin strain, whereas the original *ey*^{2} stock, under identical culture conditions, had preserved its distinctive features. Similarly, *ey*^{2} flies tested after the seventh backcross to Canton *S* had assimilated themselves to the Canton *S* pattern.

Fluorometric measurements were confined to *Fl* 4 and *Fl* 5. As in the experiments of Hadorn and Mitchell[1], these substances overlapped strongly in the first dimension. Their separation into distinct spots was achieved in the second dimension. In order to eliminate such differences in absolute quantities as might arise from the reduced size of the *ey*^{2} heads and eyes and from the variability in the eye size of the mutant, the ratio of the fluorometric values of *Fl* 5 to *Fl* 4 was determined for each chromatogram. Table 1 shows that the original *ey*^{2} stock differs significantly from the Berlin strain and from the *ey*^{2} with Berlin background. There is a small residual difference between the latter and the Berlin stock. Two sets of measurements carried out with the Canton *S* backcross series yielded comparable results.

Table 1. Ratios of Fluorometric Values *Fl* 5/*Fl* 4 in Chromatograms of Female Heads

	Berlin	*ey*^{2}	*ey* from sixth and seventh backcross to Berlin	Canton *S*	*ey* from seventh backcross to Canton *S*
Number of chromatograms	16	9	9	2	2
Ratio *Fl* 5/*Fl* 4 means	1·74	0·64	1·38	1·83	1·98
Standard error (*sm*)	±0·09	±0·03	±0·08	—	—

Significance of differences between:	Berlin and *ey*^{2}	Berlin and *ey* on Berlin background	*ey*^{2} and *ey* on Berlin background
t	9·57	2·805	8·88
p	< 0·001	0·01	< 0·001

A reciprocal backcross stock is in preparation, utilizing *ey*^{2} females and Berlin males. It is hoped that this stock may furnish information on the importance of cytoplasmic or chromosomal factors in the determination of the fluorescent pattern.

In conclusion, it should be mentioned that the fluorescent characteristics of *ey*^{2} and of Berlin flies were differentiated autonomously in eye disks transplanted reciprocally between the two strains at the third instar, and in host eyes. This autonomy was demonstrated qualitatively in a series of chromatograms prepared from transplants (9–37) and from a

corresponding number of excised host eyes (unboiled).

This investigation was started in the laboratory of Prof. Ernst Hadorn (Zurich), to whom I am indebted for advice and instruction. The fluorometric measurements were carried out by Dr. M. Finkelstein (Jerusalem), whose help is also acknowledged.

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Instability of Milk due to a High Content of Calcium Ions

In the nineteen thirties, great difficulty arose in the Netherlands from the frequent occurrence of flocculation of fresh milk on boiling and even during transportation or storing for a short time. This condition was called 'the Utrecht abnormality of milk', for it appeared first in the province of Utrecht. Afterwards this abnormality was found in other parts of the country as well[1]. The abnormality disappeared gradually; at present it is quite rare.

Milk exhibiting the Utrecht abnormality does not show any unusual value for the common numerical data (for example, *p*H, titration acidity, protein content, total calcium content). The bacterial count is normal. There was evidence, however, that the instability is caused by an abnormally high content of calcium ions[2]. But the evidence was only indirect, for at that time it was not possible to determine the calcium ion content. In recent years a reliable method for the determination of calcium ion content in milk ultrafiltrate has been developed[3,4].

In recent months we have had the good luck to obtain a few samples of milk showing the Utrecht abnormality.

The method of determination consists in using murexide (the ammonium salt of purpuric acid) as a calcium indicator and measuring with a Unicam *S.P.*500 spectrophotometer the change of colour due to the amount of calcium ion present. For full details of the method and its theoretical background refs. 3 and 4 should be consulted.

The results for four samples are listed in Table 1.

Table 1. Analysis of Four Samples of Milk showing the Utrecht Abnormality

	1	2	3	4	Normal range
*p*H	6·7	6·6	6·6	6·4	6·4–6·6
Titration acidity*	7·8	14·5	16·0	19	14–20
Heating test	+	++	+++	++	—
Alcohol test	+	++	+++	++	—
Total Ca (mgm. per cent)	176	144	216	134	120–200
Ultrafiltrable Ca (mgm. per cent)	44	34	45	54	26–46
Ca ions (mgm. per cent)†	14·8	15·2	20	27	8·0–14·4
Citric acid (mgm. per cent)†	161	74	122	208	96–288

* ml. of 0·1 *N* sodium hydroxide/100 ml. of milk.
† In the ultrafiltrate.

In complete accordance with Seekles's expectations[1], we have found the content of calcium ions to be significantly higher than normal.

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A Toxic Effect of Fluoride

Because fluoride has been shown to depress bacterial activity, and because the bacteria of the intestinal tract synthesize several vitamins which are utilized by the host, it was considered that the ingestion of large amounts of fluoride might influence the onset of specific vitamin deficiencies in a manner comparable with the effect produced by the insoluble sulpha drugs or the antibiotics.

In one set of experiments large amounts of fluorine ingested orally were found to favour the initiation of a nutritional deficiency (probably a biotin deficiency) in rats under certain conditions. In this experiment 80 parts per million of fluoride, in the form of sodium fluoride, was added to the drinking water of the experimental group. The control group received no fluoride supplements. For three weeks the following semi-synthetic diet was fed: 75 per cent sucrose, 18 per cent vitamin-free casein, 4 per cent lard, 3 per cent salts. To each 100 gm. of ration the following vitamins were added: 1 mgm. thiamine, 1·5 mgm. riboflavin, 0·5 mgm. calcium pantothenate, 0·5 mgm. pyridoxine, 10 mgm. inositol, 10 mgm. *p*-aminobenzoic acid, 10 mgm. niacin, 10 mgm. 2-methyl naphthoquinone, 40 international units vitamin A, 200 mgm. choline chloride. No change in the weights or the appearance of the animals was observed.

The diet was then changed to include 16 per cent raw egg-white, 10 per cent casein, 67 per cent sucrose, 4 per cent lard and 3 per cent salts. The vitamin supplements were the same as listed above. The egg-white was added to aid the onset of a biotin deficiency. At the beginning of the period during which this diet was used, the average weights of the three rats of the control and experimental groups were 204 and 178 gm. respectively. After sixteen days the average weights were 196 and 125 gm. One of the rats of the experimental group died at this stage.

The fur of the experimental animals was bristled and rough, and there was alopecia of the snout, head and legs, mild diffuse dermatitis, and mild 'spectacle eye'. The control animals showed none of these symptoms.

This experiment was repeated and a similar result was obtained.

The diet used had a low vitamin A and pantothenic acid content. Increasing the vitamin A content to 200 international units slightly delayed the onset of the symptoms. Increasing the calcium pantothenate content to 2 mgm. per 100 gm. of ration did not affect the result.

The toxicity of the fluoride alone was not the cause of these symptoms, because other experiments

revealed that: (*a*) 120 p.p.m. of fluorine in the drinking water did not affect the growth of rats during a seven-week period, when a natural stock diet was fed; (*b*) if the egg-white was excluded from the diet shortly after the loss of weight began, there was no further loss of weight even though the fluoride supplements were continued.

The deleterious effects described above must have been due to either a nutritional disturbance, possibly a biotin deficiency complicated by other factors, or an unknown form of toxicity resulting from the use of egg-white and fluoride during the same period. Space will not permit a discussion of the evidence for and against each hypothesis. However, in support of the former is the fact that the deleterious effect of the egg-white – fluoride combination did not occur when the egg-white was added to a natural stock diet.

In a second set of experiments large amounts of fluoride ingested orally were found not to affect the severity of riboflavin deficiency. In this work 200 p.p.m. of fluoride as calcium fluoride and 120 p.p.m. as sodium silicofluoride were included in the semi-synthetic diets of two groups of young rats. The diet was deficient in its riboflavin content. After five weeks the average weights of the animals of the control group, which had received no supplementary fluoride, and the experimental groups were approximately the same.

A similar result was obtained when fluoride was added to a diet which was deficient in pantothenic acid.

The results of further experiments which have recently been begun should help clarify the problem presented in the first experiment.

This work will be published in detail at a later date.

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Toxicity and Narcotic Activity of Fluorocarbons

Published information on the results of investigation of the toxic and narcotic activity of fluorocarbons is very scanty, and such as is available is probably invalidated because of the lack of purity of the samples used in the tests. Struck and Plattner[1], who examined C_4F_{10}, C_5F_{10} and C_6F_{12}, concluded that the materials were toxic, whereas Spiegl[2] used concentrations of C_7F_{16} and C_8F_{18} which were too low to acquit them of toxic properties. He found C_7F_{14}, of unspecified purity, to be toxic.

We have examined the physiological activity of a sample of C_7F_{14}; this had been subjected to exhaustive washing with methyl alcohol, which is known to be an excellent selective solvent for hydrofluorocarbons[3]. When tested against grain weevils by the method described by Bradbury and Armstrong[4], the compound was non-toxic and virtually devoid of narcotic activity (8 per cent knockdown after 4 hr. exposure to a thermodynamic concentration of 0·8). In a 24-hr. test, there was very slight narcosis (39 per cent at 0·9) and only 10 per cent mortality. Tests with mice at thermodynamic concentrations of 1·0 showed no narcosis and no signs of toxicity in a 1-hr. test. There were no delayed deaths.

Mullins[5] has recently referred to experiments with C_5F_{12} on mice, which failed to show either toxic or narcotic action at a thermodynamic concentration of 1·0 for 1-hr. exposures.

We believe that the results of Mullins and ourselves represent the first unequivocal evidence that fluorocarbon vapours are non-toxic when the impurities have been removed to sufficiently low limits. The unsuitability of fractionation for this purpose when applied to fluorocarbons has been emphasized by Grafstein[6] and is consistent with our experience.

The almost complete absence of narcotic activity is also noteworthy. The results obtained with C_7F_{14} may be compared with those for C_7H_{14}, which gave a 50 per cent knockdown at a thermodynamic concentration of 0·1 in a 2-hr. test with grain weevils. Ferguson[7] has similarly shown that heptane, C_7H_{16}, exhibited threshold narcosis at a concentration of 0·15 and complete narcosis at a concentration of 0·25.

It is hoped to publish a full account of this work elsewhere. We wish to thank Dr. J. Raventos, of I.C.I. (Pharmaceuticals), Ltd., for carrying out the tests on mice.

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Differential Thermogravimetry

The methods of differential thermal analysis and thermogravimetry have been used in parallel for thermal investigations of analytical precipitates[1]. This double method possesses obviously the advantage that the same thermal change can be observed and characterized by the loss of weight and the change of temperature simultaneously, the two sets of measurements checking each other, or indicating by differences of results some changes which could not otherwise have been observed. In addition, the differential thermal analysis method completes the thermogravimetry measurements in the case when no loss of weight occurs. On the basis of thermogravimetry results, accurate quantitative conclusions may be drawn, which can scarcely be made with thermograms obtained by differential thermal analysis. During our investigations materials have also been studied which, for some reason (for example, melting), could not be subjected to differential thermal analysis. This gave rise to the idea of a differential thermogravimetric method and we succeeded in developing and applying this procedure.

Our thermobalance has been constructed of an air-damped automatic analytical balance. To the beam of this a permanent magnet has been attached, which moves inside a symmetrically placed coil with a very large number of turns. On decomposition of the specimen the beam of the balance moves and causes the displacement of the permanent magnet. The

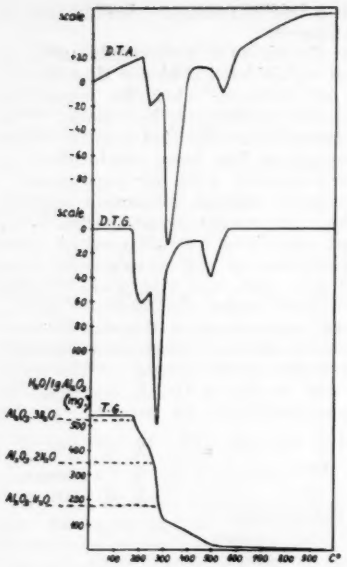

Fig. 1. Gibbsite (hydrargillite)

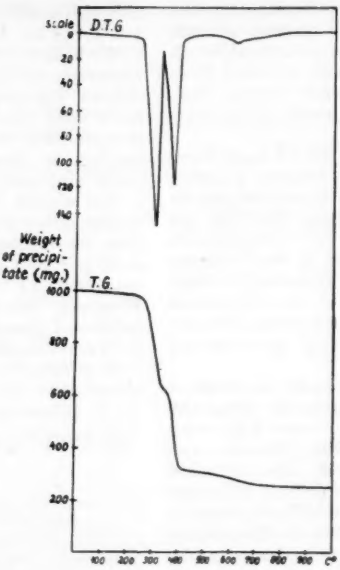

Fig. 2. Zinc anthranilate

rate of motion of the magnet corresponds to that of decomposition, and consequently a current proportional to the change of weight is induced (dm/dt). This latter is measured by means of a sensitive mirror galvanometer. Registering the values of deviations observed on the galvanometer as a function of oven-temperatures, the thermograms shown in Figs. 1 and 2 have been obtained. Fig. 1 shows differential thermal analysis (*D.T.A.*), differential thermogravimetric analysis (*D.T.G.*) and thermogravimetric analysis (*T.G.*) curves for gibbsite (hydrargillite), while Fig. 2 shows differential thermogravimetric analysis (*D.T.G.*) and thermogravimetric analysis (*T.G.*) curves for zinc anthranilate.

The many advantages of the differential thermogravimetric method may be summarized as follows.

(1) It can be carried out together with thermogravimetric measurements.

(2) The curves for differential thermal analysis and differential thermogravimetric analysis are comparable, but the results by the former method indicate even those changes of state which are not accompanied by loss of weight. The curves obtained by the latter method reflect only changes in weight, but are more reproducible.

(3) While the curves for differential thermal analysis extend over a wider temperature interval, due to the subsequent warming of the material after reaction, the differential thermogravimetric measurements indicate exactly the temperatures of starting, the maximum rate and the end of the change, and give a most attractive picture of the whole process.

(4) On the thermogravimetric curves, changes following each other immediately cannot be distinguished, as the corresponding stages coincide (Fig. 2). The differential thermogravimetric curves of the same change indicate by sharp maxima that the thermogravimetric stages can be divided in two parts.

(5) The differential thermogravimetric curves are exactly proportional to the derivatives of thermogravimetric diagrams; therefore the area under the curve gives the change of weight precisely, in contrast to the differential thermal analysis curves, where the corresponding area depends also on other factors (for example, heat conductivity, heat of translation, solidity). Accordingly, differential thermogravimetric curves enable one to make exact quantitative analyses.

(6) The method can be used for the investigation of materials which for some reason or other cannot be analysed by the differential thermal analysis method. For example, some organic compounds melt during heating, but even so, differential thermogravimetric methods yield fairly good results.

Very recently, a similar method was described by W. L. De Keyser[2] for determination of the rate of decomposition of some materials. While his method is interesting, objections can be made to its theoretical basis, for the method gives only the ratio of the finite increments of a thermogravimetric curve, whereas by our method—in the case of uniform heating—the derivative dm/dt can be obtained.

The results of our investigations will be published in detail in the *Acta Chimica* of the Hungarian Academy of Science.

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A Mechanism for the Displacement of Ions in an Ionic Lattice

The most direct way by which an ion can be displaced in an ionic lattice when the lattice is subjected to ionizing radiation is through simple collision displacements. Thus high-energy electrons can be expected to produce displacements by simple 'billiard-ball' collision; γ-rays can possibly produce displacements by Compton scattering, either by direct recoil of the ions or by producing high-energy electrons which afterwards collide with and displace ions.

Some displacement experiments I have carried out are difficult to interpret solely on a 'billiard-ball' collision mechanism. In these experiments alkali halide crystals have been bombarded with high-energy electrons giving coloration of the crystal. Some of the colour centres induced are stable against subsequent irradiation with white light, the remainder are unstable. After optical bleaching, it is observed that the crystal is 'permanently' coloured to some depth below the crystal face on which the bombarding

electrons were incident. The depth of coloration increases with increasing energy of the incident electrons, but the intensity of the coloured region is very much greater than would be the case if each bombarding electron produced one colour centre.

Moreover, for Rutherford scattering, the collision cross-section for producing displacements (high-angle scattering) approaches zero as electrons lose energy in passing through the crystal, for the smaller the incident electron energy the more nearly must the collision be 'head-on' to produce a displacement. The intensity of the coloured region might thus be expected to fall off steadily to zero with increasing distance from the incident crystal surface. In actual fact, observation shows that the intensity is of the same order throughout the depth of the coloured region and that the colour ceases quite abruptly.

To account for these features the following simple mechanism for producing displacements by any form of ionizing radiation is postulated. The incident radiation, high-energy electrons or high-energy photons (X-ray, γ-ray and possibly even ultra-violet light), ionizes the negative ions in the ionic lattice, stripping these ions of several and at least more than two electrons. The stripped electrons move through the crystal, possibly themselves producing further ionization of negative ions, and eventually become trapped either at negative-ion vacancies in the crystal or by halogen ions which are short of electrons as a result of their ionization. These stripped negative ions, which are now positively charged, are sitting uncomfortably surrounded by positively charged nearest neighbours and will be displaced into interstitial sites by the induced high Coulomb repulsive force. Such displacement may be expected to occur in a time which is of the order of a few atomic vibrations, provided that the recombination time for the recovery of the electrons by the stripped negative ions is sufficiently long ($\sim 10^{-12}$ sec.).

The Coulomb repulsion between these stripped negative ions and their environment will be less unfavourable in these interstitial sites. Here the ions will recover all but one of the electrons which were originally lost, so becoming electrically neutral. Provided that thermal activation does not restore the displaced ions from trapped sites to normal lattice sites, the remaining electron will be trapped in a negative ion vacancy. This gives rise to a colour centre which cannot be optically bleached at low temperatures (room temperature for sodium or potassium chloride, etc.).

It will be observed that such a mechanism is of importance only if: (1) the lattice bonding is heteropolar; (2) the recombination time for the stripped electrons is long compared with the time of a lattice vibration; (3) the cross-section for multiple ionization is large enough to produce an appreciable effect.

Condition (3) is justified for electron bombardment, inasmuch as cross-sections for multiple ionization decrease approximately by an order of 10 for each unit increase in the degree of ionization. Thus single ionization by electrons has a cross-section of the order of 10^{-16} cm.^{2}, double ionization 10^{-17} cm.^{2} and so on[1].

The number, n, of interstitial atoms per c.c. produced as a result of this ionization displacement mechanism is given by:

$$n = N_0 F t \sigma,$$

where σ is the ionization cross-section for multiple ionization, N_0 is the number of ions per c.c., F is the flux number of incident particles per cm.^{2} per sec., and t is the time of exposure in seconds.

Taking $\sigma \sim 10^{-19}$ cm.^{2} (fourfold ionization), it will be seen that the number of displacements per unit volume per unit integrated flux (Ft) is $\sim 1{,}000$. Thus for every incident electron per square centimetre, $\sim 1{,}000$ displacements per c.c. are produced, and this will produce a colour far more intense and uniform throughout the electron range than would be formed by a simple collision process. Any form of ionizing radiation should be capable of producing displacements by this mechanism, the magnitude of the effect depending upon the cross-section for multiple ionization and the intensity of the ionization. For example, this simple mechanism may explain the mechanical hardening of alkali halide crystals by X-rays[2].

Finally, it will be realized that if such a mechanism for producing displacements is accepted, the magnitude of the effects of radiation damage will depend markedly upon the type of radiation used and also upon the characteristics of the atomic binding forces within the crystal. For example, electron bombardment may produce considerably more damage than neutron bombardment per incident particle; again, under electron bombardment, more damage may be expected in the case of an intermediate phase in a metal alloy system in which the bonding is largely ionic and the recombination time long, than in the case of a simple solid solution or a pure metal.

I wish to acknowledge helpful discussions with Dr. W. M. Lomer and Mr. R. A. Dugdale.

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Electronegativity and the Stability of Metal Complexes

Various workers[1] have remarked on the order of stability for metals with the same complexing agent. Thus, with salicylaldehyde in 50 per cent dioxan, the order is Pd > Cu > Ni > Pb > Co and Zn > Cd > Mg, and is the same for glycine and 8-hydroxy quinoline. A further list is Cu > Ni > Zn > Pb > Co > Mn > Mg > Ca > Sr > Ba based on considerations of glycine, alanine, glycyl-glycine and several carboxylic acids[2].

However, in a critical review of the available data, Irving and Williams[3] conclude that there is only one order of stabilities, which holds almost without exception for all complexes: Mn < Fe < Co < Ni < Cu > Zn. Earlier[4], they had pointed out that this particular order of stabilities could be intelligibly correlated with the second ionization potential. Ackermann[5] had also suggested correlation with the sum of the first two ionization potentials and that the electron structure of the metal in the chelate somehow resembled that of the metal in the elementary state.

Mellor and Maley[1] briefly considered the significance of ionic radius and electronegativity in discussing the

Table 1

Metal	Electronegativity (Haïssinsky)	Metal	Electronegativity (Haïssinsky)
Ba	0·85	Co	1·7
Ca	1·0	Ni	1·7
Sr	1·0	Cu	2·0
Mg	1·2	Zn	1·5
Mn	1·4	Cd	1·5
Fe	1·65	Pd	2·0

empirical order of stability which included elements such as cadmium, palladium, lead, magnesium, etc., but did not observe any clear correlation between complex stability and ionic radius or any other parameter which might be related empirically.

An empirical relation has now, however, been found to exist between electronegativity values as calculated by Haïssinsky[6] and the stability of metal complexes. These electronegativity values calculated in an analogous manner to that of Pauling[7] from thermochemical data are shown in Table 1.

It will be observed that the order of stability given by Irving and Williams[3], namely, $Mn < Fe < Co < Ni < Cu > Zn$, is practically identical with the electronegativity order for the same metals, namely, $Mn < Fe < Co = Ni < Cu > Zn$. The 'significant' rise of ionization potential ($I_1 + I_2$) to a maximum at copper and fall at zinc, observed by Irving and Williams, is also observed with these electronegativity values. Further, a plot of log stability constants of a typical complexing agent, glycine[8], against the appropriate electronegativity values of the metals gives rise to a smooth curve (Fig. 1). Similar curves have been obtained for malonic acid, oxalic acid, ethylene diamine and alanine. This shows that complex stability is a continuous function of the electronegativity difference between metal and ligand. It appears also that metals other than those in the Irving–Williams's invariable-order list, for example, calcium and barium, fit the correlation. The slopes of the curves vary with the ligand, ethylene diamine being greater than glycine which is greater than oxalic acid. This fact is also in agreement with the general correlation of greater stability of complex with decrease in difference of electronegativity of metal and ligand.

That there should be a relationship between complex stability and electronegativity is reasonable, since the strength of any molecular bond is almost certainly a function of the electron-attracting power of the atoms in the bond, and it is probably significant that the values of the Walsh force-constant electronegativities[9] for the transition metals show the same rise in value to a maximum at copper and fall at zinc as do the Haïssinsky values. In addition to this, electronegativity difference is related to the amount of covalent character of the metal–ligand bond[10] and thus complex stability is also related to covalent character.

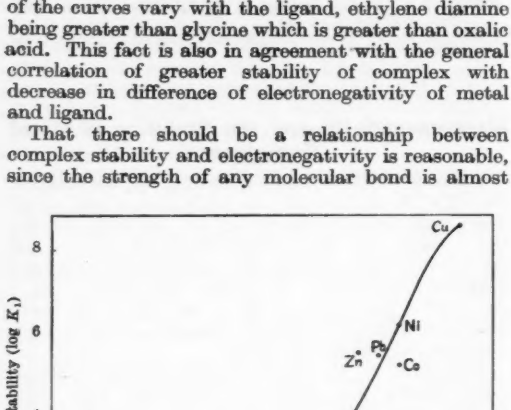

Fig. 1

From this new correlation with stability, it would seem possible to state that the stability of a metal complex in solution, and for a given ligand, is determined by two main influences: (*a*) the tendency towards or ease of formation of the complex, as governed by, for example, the second ionization potential; and (*b*) the strength of the metal–ligand bonds after complex formation, as governed by the electronegativity difference of metal and ligand. Other influences such as steric effects may also play their part, while hybridization, inductive effects, etc., in certain cases will influence the effective electronegativity difference, and hence influence the stability of the complexes.

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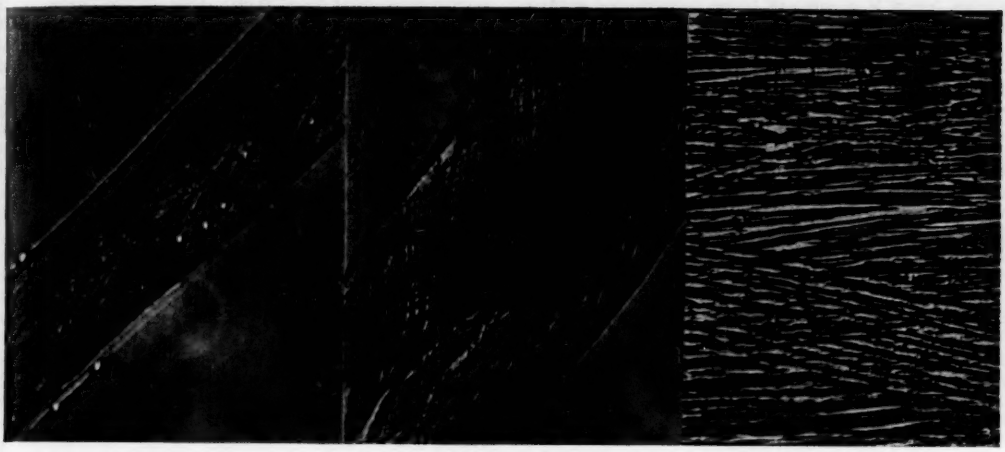
Effects of Pressure upon Collagen

During recent investigations into the microstructure of collagen fibres, we have utilized the 'crushing technique' of Boddy[1], and combined this with the interferometric method due to Merton[2]. By these means, changes in structure due to physical or chemical effects may be readily observed, and we have found that liquid globules are exuded from air-dried collagen fibre bundles under pressures in the region of 2,500 kgm./cm.[2]. Fig. 1 shows the appearance of a fibre bundle originally 35 μ in diameter, after the application of a load of approximately 2,000 kgm./cm.[2]. The globules are seen on the surface and at the edges of the bundle. These appear as discrete globules after the release of the pressure, if it has been sufficient to force the film of displaced liquid to an excessive distance. The effect of increasing the pressure to approximately 2,500 kgm./cm.[2] is shown in Fig. 2, where the displaced liquid continues to 'wet' the fibres at the perimeter of the main pressure area. The portions of fibres from which liquid has been displaced appear dark as they are virtually dry-mounted. Further work is in progress upon the nature of this liquid.

It is possible that the loss of moisture on drying which contracts the fibres and allows them to coalesce into a more or less homogeneous bundle is never com-



Collagen fibre bundle (1) after pressure has been applied, showing globules of liquid; (2) after great pressure has been applied; (3) dried before applying pressure

plete. Thus, even in the so-called dry state, the fibres possess surface films which prevent structural dissociation of the constituent fibrils and ensure the preservation of fibre identity. Continued increases of pressure expand the bundle by increasing its width and may involve rupture of fibres with splitting of the bundle if dry fibre bundles are used. It has been noted that there is a significant elastic contraction after removing the pressure, and further plastic flow of material on re-applying the loads. A point can be reached at which the elastic contraction ceases.

Fig. 3 illustrates the effects of crushing a fibre bundle containing sufficient moisture to allow the fibrils to separate; a 35-μ diameter bundle can be reduced to a unit layer of constituent fibres about 1·5 μ thick (that is, the diameter of the fibre).

Similar exudation effects have been obtained with other fibres and with tanned collagen from leather. In this case, the exudate contains oils or fats as well as moisture. Full reports on this work will appear elsewhere, but it is thought the release of what may be more or less chemically bound water by mechanical pressure may be of interest in the study of surface films and conditions on fibres.

We shall be interested to know if this has been observed under other conditions.

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Radiation Dosimetry of Iodine-132

Fission product tellurium-132 (half-life 77 hr.) is now obtainable from the Atomic Energy Research Establishment, Harwell. The daughter isotope iodine-132 is potentially valuable in a variety of tracer applications, such as double tracer experiments in conjunction with 8·0-day iodine-131 or in short-term physiological studies where minimal radiation dosage is desired[1]. The measurements reported here provide the necessary physical data for the calculation of the radiation dosage resulting from the use of iodine-132 in biological tracer investigations[2].

Tellurium-132 is obtained from the Atomic Energy Research Establishment as a dilute sulphuric acid solution containing potassium permanganate. The iodine-132 is conveniently separated as 'carrier-free' iodine by distillation following the addition of sufficient $N/10$ hydroxylamine hydrochloride to render the solution colourless. 4π β-counter measurements[3,4] indicate that longer-lived radioactivity, assumed to be due to iodine-131, accounts for less than 1 per cent of the initial radioactivity of the separated material.

The γ-ray dose-rate and total β-energy emission from iodine-132 have been measured by the ionization methods described by Gray[5]. The dose-rate at 1 cm. from 1 mc. of iodine-132 (measured by 4π β-Geiger–Müller counter) was found to be 12·1 r./hr. and the mean β-ray energy emitted per disintegration was 0·45 MeV. Collectively, these results imply a difference of approximately 3·3 MeV. between the ground-states of iodine-132 and its daughter nucleus, and this value should be correct within about 10 per cent irrespective of the precise details of the decay scheme.

The results were obtained by comparison with the γ-ray output of a radium needle, which had been carefully compared with a source held at the National Physical Laboratory, and this in turn had been calibrated there against the British Radium Standard. It was assumed that the γ-ray dose-rate from 1 mgm. of radium screened by 0·5 mm. of platinum is 8·3 r./hr. at 1 cm., and in deducing the β-ray energy emission it was further assumed that the mean energy required for the formation of 1 ion pair in air is 32·5 eV.

The β-ray energy measurement depends on the observation of the ionization in a cavity lined by a solution of the radioactive material in agar or gelatin. Corrections are applied for the effects of attenuation of the β-rays by the air in the cavity, for the limited thickness of the active lining, and for the ionization caused by the γ-rays from the lining. The chamber used had a lining 4 mm. thick, and the first two corrections were calculated on the assumption that iodine-132 has two β-rays of maximum energy[6] 2·2 and 0·9 MeV. It then follows from the experi-

mental result that each of these contributes approximately 50 per cent to the total emission of β-ray energy. The combined correction for these effects was 4·3 per cent. The γ-ray correction, based on the measured value of 12·1 r./hr./mc. at 1 cm., amounted to 8·8 per cent.

A measurement of the half-life was made on a β-ray ionization chamber, and a regression line through seven points, spread over 8 hr., gave a half-life of 2·259 ± 0·003 hr. (after correcting for 0·7 per cent iodine-131 initially present as contaminant). This figure is subject to a systematic error not greater than about 0·005 hr. due to possible error in the chamber background.

We are grateful to Dr. G. B. Cook and Mr. J. D. Eakins, of the Isotopes Division, Atomic Energy Research Establishment, Harwell, for their co-operation and their advice on the separation of iodine-132, and to the Medical Research Council for the loan of the equipment used in the ionization measurements.

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Successful Inter-breed Transfer of Ova in Sheep

Successful transfer of ova by surgical techniques in sheep has been reported by Warwick and Berry[1] and Lopyrin, Loginova and Karpov[2]. In our experiments, transfers of ova have been carried out between the Border Leicester (mature weight 140–180 lb.) and Welsh Mountain (mature weight 80–100 lb.) breeds in order to evaluate the maternal influence on the size of lambs at birth and at subsequent ages.

Thirty Welsh Mountain and twenty-five Border Leicester ewes were run with a raddled, vasectomized ram. Synchronization of the onset of œstrus in the majority of the ewes was attempted by means of progesterone treatment[3]. Four days before the expected onset of œstrus, the donors were treated with raw pregnant mare serum (stored at − 10° C.) and then run with a fertile ram of the same breed. The recipients remained with the vasectomized ram.

Laparotomy in the donors was performed 68–90 hr. after the onset of œstrus. *In vivo* recovery of the ova from the Fallopian tubes was carried out as described by Chang[4]. Either homologous blood serum or Ringer's solution was used as the flushing medium. The ova were transferred in a glass pipette which was inserted into the lumen of the uterine horn near the utero-tubal junction. Single ova were transferred to seventeen recipients and one ewe received two ova. After recuperation, the recipients were run with a fertile ram of the opposite breed.

One male and two female Border Leicester lambs were born to Welsh ewes, all requiring assistance at parturition, and five Welsh ewe lambs were born to Border Leicester ewes. The mean birth-weight of the Border Leicester lambs from the Welsh ewes was 11·1 ± 0·38 lb. after a mean gestation period of 146·0 ± 0·58 days, and that of the Welsh lambs from Border Leicester ewes was 9·5 ± 0·18 lb. after a mean gestation period of 149·6 ± 0·51 days. Birth-weights and mean gestation periods of Border Leicesters are normally 13·5–14 lb. and 145 days respectively, whereas the corresponding figures for the Welsh breed are 8–8·5 lb. and 147 days respectively.

Transfers were successful when œstrus in the recipients commenced from 16 hr. before to 20 hr. after that in the donors. Thirty-seven ova, representing 58 per cent of the ovulations, were recovered from thirteen ewes; the standard error of the recovery-rate was 20·2 per cent. Of the eight successful transfers, two were 4-cell, five 8-cell and one a 16-cell ovum. Four out of seven and four out of eleven transfers, using blood serum and Ringer's solution respectively, were successful. Prior to transfer to the recipients, seven of the ova which developed to term were exposed for 30–45 min. at room temperature, and one developed after exposure for 70 min.

Our results to date indicate that the influence of the size of the breed of the mother on birth-weight is marked, and that ovum transfer in the sheep can be as successful as in the rabbit[5].

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Mechanical Separation of Plant Tissues

An investigation was recently carried out in this Laboratory into the best way of separating the fibre strands of various 'bast' and 'leaf' fibres into their component elementary cells. The fibres were first treated by the chlorite method[1] and then divided into two parts. One part was subjected to shaking with glass beads in a glass bottle, whereas the other part was shaken in a polythene bottle with short (about 2 cm.) lengths of glass rod covered with rubber 'policemen'. Microscopical examination showed that excellent separation was effected by the second method without damage to the fibres, although damage was pronounced with the glass beads. It is possible that this method, which appears to be not generally known, may be capable of wider application for separating plant tissues.

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June 1.

[1] Spearin, W. E., and Isenberg, I. H., *Science*, **105**, 214 (1947).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 8

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Mr. T. M. Herbert: "The Application of Science in Railways" (Joule Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Methods of Teaching Technical Writing".

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Prof. G. Valette (Paris): "The Role of the Pharmacist in Phytopharmacy in the Present and the Future".

Tuesday, November 9

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. A. Wells: "The Stand Against Scientific History—Schopenhauer to Collingwood".*

BRITISH ORNITHOLOGISTS' UNION (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON, at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Dr. H. L. Løvenskiold (Norway): "The Birds of Spitzbergen".

SOCIETY FOR CULTURAL RELATIONS WITH THE U.S.S.R., SOUTHAMPTON GROUP (in the Senior Common Room, The University, Southampton), at 5 p.m.—Academician M. M. Dubinin: "Scientific Research in the U.S.S.R.".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. A. Skinner and Mr. F. R. Martin: "Some Considerations of Airfield Pavement Design".

ROYAL INSTITUTE OF CHEMISTRY in collaboration with the IMPERIAL COLLEGE CHEMICAL SOCIETY (in the Large Lecture Theatre, Chemistry Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Dr. Robert Neville Haszeldine: "Fluorocarbon Derivatives" (Meldola Medal Lecture).

SOCIETY OF CHEMICAL INDUSTRY, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. C. S. de Whalley: "The Decoloration of Sugar Liquor by Solid Absorbants".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. H. M. Finniston: "The Materials of Atomic Energy".

Wednesday, November 10

UNIVERSITY OF LONDON (at the Postgraduate Medical School, Ducane Road, London, W.12), at 2 p.m.—Dr. Barbara Clayton: "Laboratory Investigation in Endocrinology".*

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. B. W. Bradford, Mr. D. Harvey and Mr. D. E. Chalkley: "The Chromatographic Analysis of Hydrocarbon Mixtures".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND MEASUREMENTS SECTIONS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. L. Essen: "Standard Frequency Transmissions": Mr. J. McA. Steele: "The Standard Frequency Monitor at the National Physical Laboratory": Mr. H. B. Law: "Standard Frequency Transmission Equipment at Rugby Radio Station".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. V. A. Ambartsumyan (U.S.S.R.): "Stellar Systems of Positive Total Energy".* (Further Lecture on November 11.)

INSTITUTE OF PHYSICS, EDUCATION GROUP (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Dr. F. Sherwood Taylor: "Galileo".*

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 8.15 p.m.—Dr. C. M. Fleming: "Education and Psychology".

Thursday, November 11

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. Charlesby and Mr. J. J. Polling: "The Optical Properties of Thin Oxide Films on Tantalum"; Mr. M. A. H. Lanyon and Mr. B. M. W. Trapnell: "The Interaction of Oxygen with Clean Metal Surfaces".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Sir Alfred Egerton, F.R.S.: "Reflections on the Management of Heat". (Eighth Hinchley Memorial Lecture.)

INSTITUTION OF THE RUBBER INDUSTRY (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Dr. E. J. Buckler: "Nitrile Rubbers".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. G. V. Lachmann: "Boundary Layer Control".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (joint meeting with the AGRICULTURE GROUP, at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—"The Present State of our Knowledge of Ruminant Digestion". Dr. A. E. Oxford: "Its Bacteriology and Protozoology"; Dr. A. T. Phillipson: "Its Physiology".

Friday, November 12

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, St. Bartholomew's Medical College, Charterhouse Square, London, E.C.1), at 2 p.m.—Scientific Papers.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. B. J. Terrell: "Instrumentation in Engineering Research with Particular Reference to Marine Turbine Machinery".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Kenneth M. Smith, F.R.S.: "What is a Virus?"

Saturday, November 13

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. F. E. Zeuner: "The Camel and the Elephant".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with the National Diploma in Agricultural Engineering or equivalent qualifications, and with a special knowledge of agricultural engineering together with sound practical experience) IN FARM MECHANIZATION—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex (November 10).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (November 13).

ASSISTANT LECTURERS (with special qualifications in physical chemistry) IN CHEMISTRY—The Registrar, The University, Manchester 13 (November 13).

ASSISTANT (with a recognized qualification in mathematics or statistics) IN THE STATISTICS SECTION—The Secretary, Long Ashton Research Station, Long Ashton, Bristol (November 13).

LECTURER (with a first- or second-class honours degree in metallurgy or equivalent qualifications, and preferably with practical experience) IN THE DEPARTMENT OF CHEMISTRY AND METALLURGY—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (November 13).

LECTURER (Grade II) IN AGRICULTURAL BOTANY, and an ASSISTANT LECTURER IN ANIMAL HUSBANDRY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 15).

SENIOR LECTURER IN CIVIL ENGINEERING, SENIOR LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER (Grade A) IN ELECTRICAL ENGINEERING (Radio and Telecommunications), at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 15).

LECTURER (with an honours degree in zoology or agricultural zoology, and with postgraduate experience in one of the following fields: (*a*) mammalian physiology, (*b*) entomology or (*c*) parasites of plants and animals) IN AGRICULTURAL ZOOLOGY; and a LECTURER (with an honours degree in chemistry, agricultural chemistry or zoology, and with postgraduate experience in some aspect of soil research, preferably in soil classification or soil physics) IN PEDOLOGY—The Registrar, King's College (University of Durham), Newcastle-upon-Tyne (November 20).

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in engineering, physics or mathematics or equivalent qualification) IN THE MECHANICAL ENGINEERING RESEARCH LABORATORY, Department of Scientific and Industrial Research, East Kilbride, near Glasgow, for research into the following branches of mechanical engineering: properties of materials in the elastic and plastic ranges; fluid mechanics; heat transfer; lubrication; improvement of mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.551/54A (November 20).

LECTURER IN THE FLUID MOTION LABORATORY, to work on problems of electronics and instrumentation for the measurement and observation of fluid flow, including turbulence, the propagation of shock waves and aerodynamic noise—The Registrar, The University, Manchester 13 (November 27).

ASSISTANT LECTURER OR LECTURER IN CLINICAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (November 29).

PROFESSOR OF PHYSICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

SOILS CHEMIST (with a first- or second-class honours degree and at least three years postgraduate experience, and preferably with some experience of tropical soils), at the Rubber Research Institute of Malaya, Kuala Lumpur, to undertake work on soil fertility problems with particular reference to rubber cultivation—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (December 1).

CHIEF OF THE DIVISION OF FISHERIES, Commonwealth Scientific and Industrial Research Organization, to be responsible for the research activities of the C.S.I.R.O. in the fields of oceanography and marine biology, and on scientific problems relating directly to various branches of the fishing industry in Australia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 320/81 (December 15).

LECTURER (preferably with an interest and experience in vacuum techniques) IN THE DEPARTMENT OF ELECTRONICS—The Secretary and Registrar, The University, Southampton (January 1).

BACTERIOLOGIST, for sterility testing and supervision of sterile work—The Secretary, Blood Products Laboratory, Lister Institute of Preventive Medicine, Elstree, Herts.

BRITISH RAYON RESEARCH ASSOCIATION RESEARCH SCHOLAR (with a first- or top second-class honours degree in physics or physical chemistry), to work in the Department of Textile Chemistry on rheological problems connected with the interaction of water with assemblages of hygroscopic fibres—The Registrar, College of Technology, Manchester 1.

GRADUATE (preferably with some knowledge of electrical engineering) for work concerned with experimentation and re-design of control points in steelworks to fit the human operator—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Control".

LIBRARIAN (with a science degree and a working knowledge of French and German)—The Director, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans.

MASTER to teach physics to scholarship level—The Headmaster, Malvern College, Malvern, Worcs.

ORGANIC CHEMISTS (Ph.D. or equivalent experience) to continue research on the degradation of carbohydrates—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

PHYSICIST or ELECTRICAL ENGINEER (with a first- or second-class honours degree or equivalent in physics or electrical engineering and with research experience in physical optics, photoelectricity, photographic processes or electronics) at the Ministry of Supply, London Headquarters, for duties which include the preparation of contract proposals for research and development projects, scrutiny of specifications, supervision of the work and assessment of results—The Ministry of Labour and National Service, Scientific and Technical Register (K), 26 King Street, London, S.W.1, quoting A.291/54A.

PHYSICISTS (with a first- or second-class honours degree) for fundamental research on (*a*) friction, adhesion and abrasion, and (*b*) ionic diffusion in proteins using radar tracer methods—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

RESEARCH ASSISTANT (preferably with previous experience of either X-ray crystallography or large-scale computing) IN THE DEPARTMENT OF ORGANIC AND STRUCTURAL CHEMISTRY, to be a member of a small group engaged in preparing programmes for, and carrying out, extensive crystallographic calculations on the Manchester University electronic digital computer—Prof. E. G. Cox, Department of Inorganic and Structural Chemistry, The University, Leeds 2.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering or in chemistry with a diploma in chemical engineering, or A.M.I.Chem.E. and preferably with two to four years experience in plant development work), for work covering a wide range of chemical plant development and design problems in the radioactive and inorganic fields—The Senior Recruitment Officer, United Kingdom Atomic Energy Authority, Aldermaston, Berkshire, quoting 248/WGE/2.

TECHNICIAN IN THE DEPARTMENT OF PHYSICS—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1.

TECHNICIAN (with previous experience in a biological or chemical laboratory) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement

Great Britain and Ireland

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations. Season 1952–53. Northern Nigeria. By H. E. King and M. A. Choyce. Pp. 19. (London: Empire Cotton Growing Corporation, 1954.) 9*d*. [208

Department of Scientific and Industrial Research. Building Research Station. National Building Studies—Special Report No. 23: A Study of Concreting Methods on Housing Sites. By K. G. H. Fryer and J. F. Eden. Pp. vi+46+8 plates. (London: H.M. Stationery Office, 1954.) 2*s*. 6*d*. net. [208

The Work of the USSR Academy of Sciences in 1953. By N. M. Sisakian. S.C.R. Bulletin, Vol. 1, No. 2, August 1954. (Report to the Annual Meeting of the Academy, February 1, 1954.) Pp. 17–32. (London: Society for Cultural Relations with the USSR., 1954.) 1*s*. 6*d*. [208

Bulletin of the British Museum (Natural History). Botany. Vol. 1, No. 4: Notulae Criticae ad Floram Hispaniae Pertinentes, 1. By V. H. Heywood. Pp. 81–122. 10*s*. Vol. 1, No. 5: Cotoneasters from the Eastern Himalaya. By Tse-Tsun Yü. Pp. 123–142+plates 3 and 4. 6*s*. (London: British Museum (Natural History), 1954.) [208

Planning. Vol. 20, No. 369, 16 August 1954: The Menace of Air Pollution. Pp. 189–216. (London: Political and Economic Planning, 1954.) 2*s*. [208

The Registrar General's Statistical Review of England and Wales for the year 1952. Tables, Part 2, Civil. Pp. viii+184. (London: H.M. Stationery Office, 1953.) 6*s*. net. [208

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S.). No. 16, May 7, 1954: An Investigation of the Thorium Content of Manganese Nodules Using Nuclear Plates. By C. M. E. Matthews. Pp. 275–288. 2*s*. No. 17, July 16, 1954: Development in *Podocarpus nivalis* in Relation to Other Podocarps. 2: Embryogeny in *Eupodocarpus*. By Patricia Boyle and J. Doyle. Pp. 289–312+plates 16–18. 7*s*. No. 18, July 26, 1954: The Angular Scattering of Blue, Green, and Red Light by Sea Water. By W. R. G. Atkins and H. H. Poole. Pp. 313–324. 3*s*. No. 19, July 23, 1954: Some Cataclastic Features of the Leinster Granite and Their Mechanical Significance. By J. C. Brindley. Pp. 325–338+plate 18. 4*s*. (Dublin: Royal Dublin Society, 1954.) [208

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 4: Analytical Chemistry of the Proteins and Amino-Acids. By Prof. H. D. Springall. Pp. ii+17. (London: Royal Institute of Chemistry, 1954.) [248

Colonial Office. Annual Report on the East Africa High Commission, 1953. Pp. ii+100+4 plates. (Colonial 305.) (London: H.M. Stationery Office, 1954.) 3*s*. 6*d*. net. [248

Registrar General's Statistical Review of England and Wales for the year 1950. Text, Medical. Pp. x+226. (London: H.M. Stationery Office, 1954.) 6*s*. 6*d*. net. [248

Torquay Natural History Society. Transactions and Proceedings. Vol. 11, Part 3: The Torquay Natural History Society 1844–1954. By A. G. Madan. List of Officers—Proceedings—Report and Accounts. Pp. 99–142+1 plate. (Torquay: Torquay Natural History Society, 1954.) [248

Ministry of Agriculture and Fisheries: Plant Pathology Laboratory. Crop Protection Products. Approved Scheme—Approved List, 1954. Pp. 16. (London: Ministry of Agriculture and Fisheries, 1954.) [248

Privy Council. Medical Research Council Special Report Series. No. 283: Air Disinfection with Ultra-Violet Irradiation: Its Effect on Illness among School-children. By the Air Hygiene Committee. Pp. viii+88+6 plates. (London: H.M. Stationery Office, 1954.) 7*s*. net; 1.60 dollars. [278

Other Countries

British Honduras. Annual Report of the Forest Department for the year 1953. Pp. 25. (British Honduras: Forest Department, 1954.) [178

Physical Technique of Atomic Science and the Earth. By A. J. Roberts. Pp. 12. (Monroe, Mich.: Engineering Research and Sales Co., 1953.) [208

West African Institute for Oil Palm Research. Quarterly Progress Report No. 9: April 1, 1954 to 30 June, 1954. Pp. 14. (Benin City: West African Institute for Oil Palm Research, 1954.) [208

Tanganyika. Annual Report of the Geological Survey Department, 1953. Pp. iv+34. (Dar-es-Salaam: Government Printer, 1954.) 2/50 shs. [248

Uganda Protectorate. Annual Report of the Forest Department for the year ended 31st December 1953. Pp. 1+45+4 plates. (Entebbe: Government Printer, 1954.) 2*s*. [248

Administration Report of the Director of National Museums, Ceylon, for 1953. By P. E. P. Deraniyagala. Pp. 26. (Colombo: Government Publications Bureau, 1954.) 80 cents. [248

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. Interim Reports. No. 7: Heard Island. Prepared by P. G. Law and T. Burstall. Pp. iii+32+12 plates. (Melbourne: Department of External Affairs, Antarctic Division, 1953.) [248

Report of the Twenty-Eighth Meeting of the Australian and New Zealand Association for the Advancement of Science. Brisbane Meeting, May, 1951. Edited by Prof. D. A. Herbert. Vol. 28—Jubilee Meeting. Pp. xxxiii+199. (Brisbane: Government Printer, 1951.) [268

Australian and New Zealand Association for the Advancement of Science. Report of the Twenty-Ninth Meeting. Sydney, August, 1952. Edited by J. F. Kefford. Vol. 29. Pp. x+386. (Sydney: Government Printer, 1953.) [268

Chicago Natural History Museum. Fieldiana—Geology, Vol. 10, No. 17 (July 29, 1954): Fauna of the Vale and Choza—7. Pelycosauria: Family Caseidae. By Everett Claire Olson. Pp. 193–204. 25 cents. Vol. 10, No. 18 (July 29, 1954): Fauna of the Vale and Choza—8. Pelycosauria: *Dimetrodon*. By Everett Claire Olson. Pp. 205–210. 10 cents. Vol. 10, No. 19 (July 29, 1954): Fauna of the Vale and Choza—9. Captorhinomorpha. By Everett Claire Olson. Pp. 211–218. 15 cents. Fieldiana—Zoology. Vol. 34, No. 26 (July 23, 1954): Notes on the Frogs of the Genus *Telmatobius*, with descriptions of Two New Peruvian Species. By Karl P. Schmidt. Pp. 277–288. 20 cents. Vol. 34, No. 27 (July 23, 1954): Bats from Chimanta-Tepui, Venezuela, with remarks on *Choeroniscus*. By Colin Campbell Sanborn. Pp. 289–294. 10 cents. (Chicago: Chicago Natural History Museum, 1954.) [278

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 35, No. 7, (July 1954): Morbidity and Mortality Trends in Poliomyelitis. Pp. 12. (New York: Metropolitan Life Insurance Company, 1954.) [278

United States Department of Agriculture. Leaflet No. 361: The Golden Nematode of Potatoes and Tomatoes: How to Prevent its Spread. Pp. 4. 5 cents. Leaflet No. 362: The Sugarcane Beetle on Corn in the Southern States. Pp. 4. 5 cents. Farmers' Bulletin No. 2062: How to Spray the Aircraft Way: a Guide for Farmers and Spray-Plane Pilots. Pp. 32. 15 cents. Technical Bulletin No. 1093 (July 1954): Parasitic Wasps of the Catolaccus Group in the Americas. By B. D. Burks. Pp. 19+2 plates. 15 cents. (Washington, D.C.: Government Printing Office, 1954.) [278

Bulletin of the Earthquake Research Institute, Tokyo University. Part 2: Gravity Survey along the Lines of Precise Levels throughout Japan by Means of a Worden Gravimeter. Part 2: Chûgoku District. By Chuji Tsuboi, Akira Jitsukawa and Hirokazu Tajma. Part 3: Supplement to the Previous Report of the Gravity Survey in Shikoku. By Chuji Tsuboi. Pp. 47–124. (Tokyo: Earthquake Research Institute, Tokyo University, 1954.) 337 yen. [278

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